

Revised Report of
Stephen C. Meyer, Ph.D.
 May 19, 2005

Case: Tammy Kitzmiller, et al v. Dover Area School District and Dover Area School District Board of Directors

Case No. 04-CV-2688

TABLE OF CONTENTS

I.	Credentials as Expert Witness	2
II.	Summary of General Opinion	4
III.	Amplification of General Opinion	8
A.	<u>The Scientific Character of the Contemporary Theory of Intelligent Design</u>	10
1.	Both the Theory of Intelligent Design and Neo-Darwinism Address a Question—How Did the Appearance of Design in Living Systems Arise—that Has Long Been Part of Historical and Evolutionary Biology.	10
2.	The Theory of Intelligent Design Does (contra Pennock) Employ a Scientific Method	13
3.	Biological Evidence Supports the Theory of Intelligent Design	15
4.	There is, contra Forrest, Peer-reviewed and Peer-edited Scientific Literature Supporting the Theory of Intelligent Design.	20
B.	<u>The Failure of Demarcation Arguments</u>	22
1.	Scientists Have Abandoned the Search for Rigid Demarcation Criteria Such as Those Pennock Employs	23
2.	Specific Demarcation Criteria Applied to the Origins Question Fail to Distinguish Design from Its Competitors	27
3.	Pennock's Specific Demarcation Criteria Fail to Disqualify the Theory of Intelligent Design	30
4.	Further Problems with the Principle of Methodological Naturalism	37
C.	<u>Teaching about the Theory of Intelligent Design Does Not Constitute an Establishment of Religion</u>	39
1.	Pennock Provides No Criterion to Determine What Constitutes Religion	39
2.	Metaphysical Implications Are Not Unique to the Theory of Intelligent Design	40
3.	Theistic Implications No More Make Intelligent Design a Religion than the Religious (or Anti-religious) Implications of Neo-Darwinism	42
4.	The Theory of Intelligent Design Does Not Affirm Narrow Sectarian Doctrines	45
5.	Religious Motivations of Scientists Do Not Disqualify the Scientific Theories They Advocate	46
IV.	Conclusion	48
V.	Additional Information Regarding Testimony	50
	<u>Appendix A: Publications Supporting the Theory of Intelligent Design</u>	51
	<u>Appendix B: Curriculum Vitae of Stephen C. Meyer, Ph.D.</u>	58

I. Credentials as Expert Witness

I am a senior fellow and director of the Center for Science & Culture at Seattle's Discovery Institute, a think tank that funds scientific research on the theory of intelligent design. I have been University Professor of the Conceptual Foundations of Science at Palm Beach Atlantic University since fall 2002. Previously I served as Associate Professor of philosophy at Whitworth College where I taught philosophy and philosophy of science for 12 years from 1990-2002.

I received my Ph.D. from the University of Cambridge in 1991 in the History and Philosophy of Science. In my dissertation, I examined the methodological features of scientific theories of origins, including origin-of-life studies and Darwinian evolution. Historians and philosophers of science study the practices and methods of science. Thus, this disciplinary expertise in the history and philosophy of science is relevant to adjudicating questions about the nature and definition of science. My Cambridge dissertation later formed the basis of a scholarly article, *The Scientific Status of Intelligent Design: The Methodological Equivalence of Naturalistic and Non-Naturalistic Origins Theories* published in *SCIENCE AND EVIDENCE OF DESIGN IN THE UNIVERSE* (Ignatius Press, 2000). This article specifically addressed the question of (1) whether the theory of intelligent design could be considered scientific in character and (2) whether attempts to define design as inherently unscientific could be justified on the basis of various demarcation criteria. My expertise on demarcation arguments and the definition and nature of science was recognized when I was asked by a distinguished editorial board of historians and philosophers of science to contribute an article on *The Demarcation of Science & Religion* to *THE HISTORY OF SCIENCE & RELIGION IN THE WESTERN TRADITION: AN ENCYCLOPEDIA* (Garland 2000).

I have also co-edited and contributed to a peer-reviewed volume, *DARWINISM, DESIGN & PUBLIC EDUCATION* (Michigan State University Press, 2003) that treats the scientific, legal, and pedagogical issues surrounding the debate about biological origins. Additionally, my testimony before the Ohio State Board of Education and my subsequent editorials in the *CINCINNATI INQUIRER* and the *COLUMBUS DISPATCH* played a role in the Ohio Board's 2002 decision to require students

to “critically analyze” evolutionary theory—the first statewide endorsement of such a policy. I have also testified before the U.S. Commission on Civil Rights about the problem of viewpoint discrimination in the public school biology curriculum.¹

I have also co-authored a law review article with two law professors that appeared in the Utah Law Review. The article specifically addresses the question of whether teaching about the theory of intelligent design is constitutionally permissible. An earlier version of this article² was quoted by Senator Rick Santorum³ of Pennsylvania in support of the inclusive controversy-based approach to teaching biological evolution recently advocated by the U.S. Congress.⁴ The so-called “Santorum language” in support of this policy was included in the Conference Report that accompanied the No Child Left Behind Act.⁵

1. Available at <http://www.discovery.org/scripts/viewDB/index.php?command=view&id=92>.

2. DEWOLF, MEYER & DEFORREST, INTELLIGENT DESIGN IN PUBLIC SCHOOL SCIENCE CURRICULA: A LEGAL GUIDEBOOK, Foundation for Thought and Ethics, 1999, available at <http://guweb2.gonzaga.edu/~dewolf/fte2.htm>.

3. The language he quoted reads:

Several benefits will accrue from a more open discussion of biological origins in the science classroom. First, this approach will do a better job of teaching the issue itself, both because it presents more accurate information about the state of scientific thinking and evidence, and because it presents the subject in a more lively and less dogmatic way. Second, this approach gives students greater appreciation for how science is actually practiced. Science necessarily involves the interpretation of data; yet scientists often disagree about how to interpret their data. By presenting this scientific controversy realistically, students will learn how to evaluate competing interpretations in light of evidence--a skill they will need as citizens, whether they choose careers in science or other fields. Third, this approach will model for students how to address differences of opinion through reasoned discussion within the context of a pluralistic society.

Congressional Record, June 13, 2001.

4. Senator Santorum described his amendment as follows:

Mr. SANTORUM. Mr. President, I rise to talk about my amendment which will be voted on in roughly 40 minutes. This is an amendment that is a sense of the Senate. It is a sense of the Senate that deals with the subject of intellectual freedom with respect to the teaching of science in the classroom, in primary and secondary education. It is a sense of the Senate that does not try to dictate curriculum to anybody; quite the contrary, it says there should be freedom to discuss and air good scientific debate within the classroom. In fact, students will do better and will learn more if there is this intellectual freedom to discuss.

I will read this sense of the Senate. It is simply two sentences--frankly, two rather innocuous sentences--that hopefully this Senate will embrace:

“It is the sense of the Senate that--

“(1) good science education should prepare students to distinguish the data or testable theories of science from philosophical or religious claims that are made in the name of science; and

“(2) where biological evolution is taught, the curriculum should help students to understand why this subject generates so much continuing controversy, and should prepare the students to be informed participants in public discussions regarding the subject.”

Congressional Record, June 13, 2001.

5. Opponents to the “teach the controversy” approach have contested whether or not the Conference Report language is authoritative, and whether the No Child Left Behind Act accepted or rejected Santorum's language. For an analysis of this issue, see “The No Child Left Behind Act and the Santorum Language,”

I have also written peer-reviewed or peer-edited scientific articles on the theory of intelligent design. For example, in August 2004 an extensive review essay of mine advocating the theory of intelligent design appeared in the PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON.⁶ The PROCEEDINGS is a peer-reviewed biology journal published at the National Museum of Natural History at the Smithsonian Institution in Washington D.C.⁷ Previously I worked as a geophysicist with the Atlantic Richfield Company after earning degrees in Physics and Geology. I also co-authored the book SCIENCE AND EVIDENCE OF DESIGN IN THE UNIVERSE (2000), and have contributed to several scientific or scholarly books on the topic of biological origins, including most recently DEBATING DESIGN (Cambridge University Press 2004). I have also written numerous editorials on science and science education policy appearing in such publications as the WALL STREET JOURNAL, the LOS ANGELES TIMES, the BALTIMORE SUN, the SAN FRANCISCO CHRONICLE, and the HOUSTON CHRONICLE.

I also co-authored the script of a science documentary about the theory of intelligent design titled UNLOCKING THE MYSTERY OF LIFE, which aired on PBS stations around the country. And I've been asked to appear as a guest to debate scientific issues and science education policy on such national television and radio programs as *Topic A on CNBC*, *BBC Radio 4 News*, *The Jim Lehrer News Hour*, *Fox TV News with David Asman*, *Hardball with Chris Matthews*, *Talk of the Nation with Ray Suarez*, *Science Friday with Ira Flatow*, PBS's *Technopolitics*, and PBS's *Freedom Speaks*.

II. Summary of General Opinion

In this opinion I will rebut the work of Robert Pennock, Barbara Forrest, Brian Alters, Kevin

<http://www.discovery.org/scripts/viewDB/index.php?command=view&id=2103&program=CSC%20-%20Science%20and%20Education%20Policy%20-%20Federal%20Policy%20-%20MainPage>

6. S.C. Meyer, "The Origin of Biological Information and the Higher Taxonomic Categories," *Proceedings of the Biological Society of Washington*, 117(2) (2004): 213-239.

7. In the article, "The Origin of Biological Information and the Higher Taxonomic Categories," I argued that no current materialistic theory of evolution accounts for the origin of the information necessary to build novel animal forms, and proposed intelligent design as the best explanation for the origin of biological information necessary to build these higher taxa.

Padian, and Kenneth Miller to the extent that they address issues within areas of my disciplinary expertise—the history and philosophy of science, the philosophy of biology, the scientific and legal standing of the contemporary argument for intelligent design, science education policy, the Center for Science and Culture, and the intelligent design research community.

The main focus of my rebuttal will be the report filed by Robert Pennock. In particular, I will argue:

- (a) that there are good—if convention-dependent—reasons to affirm the scientific character of the contemporary theory of intelligent design;
- (b) Pennock offers no good reasons for denying the scientific character of the contemporary theory of intelligent design. The “demarcation” criteria Pennock employs to deny the scientific character of intelligent design do not distinguish the scientific status of the theory from its chief rivals (such as neo-Darwinism⁸ or chemical evolutionary theory⁹). Moreover, other attempts to do so also have inevitably failed;
- (c) Teaching about the theory of intelligent design does not constitute an establishment of religion; Pennock cites no criterion or test (legal or otherwise) to justify his claim that intelligent design is religion.

I will amplify each of these three major points in the rest of this summary of my opinion, and in my full opinion in the next section.

A. The Scientific Character Of The Contemporary Theory Of Intelligent Design

Contrary to Pennock, there are good practical, if convention-dependent, reasons for affirming the scientific character of intelligent design:

8. Neo-Darwinism is the long dominant theory of biological evolution which affirms that (1) all organisms have evolved from a common ancestor; and (2) the mechanism of natural selection acting on random genetic mutations is the primary mechanism by which evolution occurred.

9. Chemical evolutionary theory (sometimes called evolutionary abiogenesis) attempts to explain how the first life arose via undirected chemical processes from nonliving chemicals.

1. Both the theory of intelligent design and neo-Darwinism address a question—how did the appearance of design in living systems arise—that has long been part of historical and evolutionary biology.
2. The theory of intelligent design, *contra* Pennock, proposes a scientific method for detecting intelligent causes;
3. Scientists cite biological evidence sciences in support of the theory of intelligent design; there is, *contra* Pennock, an empirical basis for the theory of intelligent design.
4. There is, *contra* Forrest, peer-reviewed and peer-edited scientific literature supporting the theory of intelligent design.

B. The Failure of Demarcation Arguments

I will also argue, *contra* Pennock, that there are no good in-principle reasons for denying the scientific character of the contemporary theory of intelligent design because:

1. Attempts to define science normatively by reference to rigid demarcation criteria (of the kind that Pennock employs) have failed within the philosophy of science, the relevant discipline for adjudicating questions about the nature and definition of science.
2. Even if demarcation arguments in general could define science normatively, specific attempts to distinguish the scientific status of the theory of intelligent design from its main theoretical competitors by reference to demarcation criteria have failed.
3. The specific demarcation arguments that Pennock uses in his testimony also fail to distinguish the scientific status of the theory of intelligent design from rival hypotheses. The theory of intelligent design can be tested, in particular, in the same way as other historical and/or evolutionary hypotheses, namely,

by comparing its explanatory power against its main competitor hypotheses.

4. In virtue of (1), (2), and (3) above, and other considerations, the principle of methodological naturalism can not be justified as a normative principle of scientific reasoning, though Pennock tacitly employs this principle to disqualify the theory of intelligent design from consideration as a scientific hypothesis.

C. Teaching about the Theory of Intelligent Design Does Not Constitute an Establishment of Religion

I will also dispute Pennock's claim that theory of intelligent design is "religion" on the grounds that:

1. Pennock provides no philosophically-cogent or legally-relevant definition of religion to ground his judgment that intelligent design is religion. The constitutionally relevant criterion that Pennock could cite (the *Lemon* test) does not support his judgment either.
2. Pennock incorrectly assumes that scientific theories cannot have larger metaphysical, religious or world-view implications. In particular, Pennock fails to acknowledge that many evolutionary biologists think that neo-Darwinism (and other materialistic theories of origin) have larger metaphysical, religious, anti-religious or world view implications.
3. The possible theistic implications of the theory of intelligent design do not make it a religion (for constitutional purposes or otherwise) or negate its scientific character—any more than the possible metaphysical, religious (or anti-religious) implications of neo-Darwinism make it a religion or negate its scientific character.
4. The theory of intelligent design does not affirm any narrow sectarian religious beliefs, even if it may have broadly theistic or deistic implications.

5. The religious, or anti-religious motivations of advocates of competing theories are, contra Forrest, irrelevant to the merits of the theories that they advocate. The presumed religious motives of the advocates of the theory of intelligent design do not make the theory a religion (for constitutional purposes or otherwise) or negate its scientific character—any more than the religious (or anti-religious) motives of neo-Darwinists make neo-Darwinism a religion or negate its scientific character.

III. Amplification of General Opinion

Pennock claims—without substantiation—in his report that there is no biological evidence supporting the theory of intelligent design. Nevertheless, Pennock's main arguments against the theory have nothing to do with evidence, but instead with arguments about the definition and nature of science. Indeed, Pennock does not attempt to rebut the evidentiary or empirical arguments of the scientists who advocate the theory of intelligent design, since in this context formulating such rebuttal would be entirely fruitless. Given that many competent Ph.D.-level scientists have made affirmative evidence-based arguments for the theory of intelligent design in peer-reviewed or peer-edited scientific books, scientific anthologies, scientific conference proceedings and scientific journals,¹⁰ disputing the evidentiary case for intelligent design would only establish the fact of a scientific disagreement about the evidential standing of the theory among competent experts. Since school boards have broad discretion to decide which scientific controversies to include in their curriculum, the plaintiffs need Pennock (or some expert witness) to take an entirely different tack in testimony.

Rather than merely arguing that the theory of intelligent design incorrectly—by their lights—*interprets* the relevant scientific evidence, opponents of discussing intelligent design in the classroom need to establish: (1) The theory of intelligent design is inherently unscientific, such that the controversy about it is not a *scientific* controversy at all. Further, they need to establish that

10. See Appendix A.

(2) The theory of intelligent design is inherently religious such that teaching about it would establish a constitutionally proscribed form of religion in the public schools. (Indeed, even establishing (1) by itself—i.e., that the theory of intelligent design is “not scientific” is not sufficient in this context, since merely failing to classify a theory properly for curriculum purposes does not by itself create a constitutional issue. Only when a school district mistakenly requires teaching a religious theory in a manner that constitutes an establishment of religion does a constitutional issue arise. Just because a theory is not scientific does not necessarily make it religious.¹¹)

In any case, to establish that the theory of intelligent design is both (1) inherently unscientific and (2) inherently religious, Pennock needs much more than empirical arguments; he needs to apply normative definitions of science and religion.

In particular, he needs to identify the criteria by which scientific theories can be defined and distinguished from nonscientific, metaphysical and/or religious beliefs. In the philosophy of science, such criteria are known as “demarcation criteria.” Demarcation criteria purport to distinguish scientific theories from pseudo-scientific, metaphysical or religious ideas, on the basis of criteria of scientific practice or method (such as testability, use of law-like explanation, reliance on observable data, repeatability, etc.).

Pennock also needs similar criteria for judging when an idea or theory constitutes “religion,” or more precisely, when teaching about a theory or idea would constitute an impermissible establishment of religion.

With respect to a definition of science, Pennock provides one main definitional criterion, namely, “testability,” and two subsidiary criteria which he claims are necessary for scientific theories to be testable—namely, the reliance on observable evidence and law-like processes. As I will discuss in more detail below, these criteria do not justify exclusion of the theory of intelligent design from consideration as a scientific theory since intelligent design is manifestly testable in the same way as other historical scientific theories such as neo-Darwinism.

With respect to a definition of religion, Pennock provides none. Pennock makes no appeal to any criterion or test (*Lemon* or otherwise) to justify his claim that intelligent design constitutes

11. Larry Laudan, *Science at the Bar—Causes for Concern*, in *BUT IS IT SCIENCE?* 351, 355 (Michael Ruse ed., 1988).

“religion.” Further, he specifies no legally-relevant or normative criteria for defining an establishment of religion and no philosophically-cogent criteria for distinguishing scientific from religious theories or ideas. Instead, he simply assumes—without any justification and despite well-known counterexamples that undermine his position—that religious ideas or propositions cannot have a scientific basis and, conversely, that scientific theories cannot also be religious, or at least have religious or metaphysical implications.

Notwithstanding his failure to offer sufficient definitional criteria to ground his judgments, Pennock concludes the theory of intelligent design is both inherently (that is, by definition) unscientific and religious.

I will rebut the two main claims he makes in more detail in the discussion below.

A. The Scientific Character of the Contemporary Theory of Intelligent Design

There are good practical—if convention-dependent—reasons for regarding the theory of intelligent design as scientific, or at least as scientific as its chief rivals—neo-Darwinism and chemical evolutionary theory—both of which are taught in biology textbooks and both of which are regarded as scientific theories within the scientific community. In particular:

1. *Both the Theory of Intelligent Design and Neo-Darwinism Address a Question—How Did the Appearance of Design in Living Systems Arise—that Has Long Been Part of Historical and Evolutionary Biology.*

Biologists have long noted that many features of living systems look as though they were designed by a purposive intelligence. Both Darwin himself, and contemporary neo-Darwinists such as Francisco Ayala, Richard Dawkins and Richard Lewontin, acknowledge that biological organisms *appear* to have been designed. As Richard Dawkins puts it, “Biology is the study of complicated things that appear to have been designed for a purpose.”¹² Nevertheless, for neo-Darwinists, the appearance of design is illusory because the mechanism of natural selection acting on random variations (or genetic mutations) can fully account for the appearance of design in living organisms. As Francisco Ayala, a former president of the American Association for the Advancement of

12. RICHARD DAWKINS, *THE BLIND WATCHMAKER* (1986), p. 1.

Science, has explained:

The functional design of organisms and their features would therefore seem to argue for the existence of a designer. It was Darwin's greatest accomplishment to show that the directive organization of living beings can be explained as the result of a natural process, natural selection, without any need to resort to a Creator or other external agent.¹³

The denial of actual design in biology is central to Darwinian thought. During the 19th century, many biologists thought the superb adaptation of organisms to their environments provided strong evidence of design. Birds have wings and fly in the air; fishes have fins and gills and live in the water; mammals that live in cold climates have thick fur. Darwin, however, sought to explain such appearances of design without an appeal to actual design.

To do this he drew a famous analogy to artificial breeding experiments. Darwin knew that human breeders could change the characteristics of a population by the process of selective breeding. A farmer that bred only his fastest young stallions with his fastest mares could after several generations produce a population of speedy "thoroughbreds" adapted for racing. Darwin argued that nature could imitate this process of selective breeding and in the process cause organisms to adapt to their environment. For example, the presence of unusually fast predatory wildcats would imperil all but the fastest horses in a wild herd. After several generations of such predatory challenge the speed of the remaining herd might exhibit a discernable increase. Thus, environmental forces (predators, changes in weather, competition for food, etc.) could accomplish the same work as an intelligent human breeder. Darwin saw that a natural process—his mechanism of natural selection—could mimic, over time, the action of a selecting intelligence—a designer. Thus, as Harvard evolutionary biologist Ernst Mayr has explained, "the real core of Darwinism ... is the theory of natural selection. This theory is so important for the Darwinian because it permits the explanation of adaptation, the 'design' of the natural theologian, by natural means, . . ."¹⁴ In short, Darwinism explained the appearance of design without a designer.

But has Darwinism, or modern neo-Darwinism, explained the origin of all appearances of design in biology? Many contemporary scientists now doubt this. Some of them support a theory

13. Francisco Ayala, "Darwin's Revolution," in *Creative Evolution?!*, eds. J. Campbell and J. Schopf (Boston, Mass.: Jones and Bartlett Publishers, 1994), pp. 4-5.

14. Ernst Mayr, *Foreword*, MICHAEL RUSE, *DARWINISM DEFENDED*, xi-xii (1982).

of biological origins known as the theory of intelligent design. The theory of intelligent design holds that certain features of biological systems—such as the miniature machine, complex circuits and digital information now found in cells—are best explained as the result of a designing intelligence rather than an undirected natural process such as natural selection acting on random variation. Design advocates do not necessarily reject the idea of evolution, meaning that biological organisms have changed over time, or even that the idea that all biological organisms evolved from a common ancestor. But design theorists do reject the Darwinian explanation of apparent design; thus, they have named their theory “the theory of intelligent design” to distinguish it from the idea that a purely undirected process produced the appearance of design in living organisms. In other words, the theory of intelligent design holds that some features of biological systems look designed because they really were designed.

Is design in biology real or apparent? Clearly, there are two possible answers to this question. Neo-Darwinism provides one answer to the question and the theory of intelligent design provides the opposite answer. By almost all accounts the Darwinian answer to this question is a scientific proposition. But what then is the status of the opposite answer? If the proposition “Jupiter is made of methane gas” is a scientific proposition, then the proposition “Jupiter is not made of methane gas” would seem to be a scientific proposition as well. If the proposition “humans have free will” is classified as a metaphysical (rather than scientific) claim, then the proposition “humans do not have free will” should logically be classified in the same way. The negation of a proposition does not make it a different type of claim. Similarly, the claim “the appearance of design in biology does not result from actual design” and the claim “the appearance of design in biology does result from actual design” are not two different kinds of propositions; they represent two different answers to the same question, a question that has long been part of evolutionary biology. Indeed, it is impossible to understand Darwin’s argument in *The Origin of Species* apart from understanding how he argues against the 19th-century version of the design hypothesis. The Darwinian mechanism (which functions in Darwinian thought as a kind of “designer substitute”) and the theory of intelligent design are dialectical complements. Thus, if one is scientific, then it would seem, *prima facie*, that the other is scientific as well.

2. *The Theory of Intelligent Design Does (contra Pennock) Employ a Scientific Method*

But can the possibility of intelligent design be explored in a scientific way? Since the 1980s, a growing number of scientists have asserted that, contrary to neo-Darwinian orthodoxy, nature displays abundant evidence of real, not just apparent, design. These scientists, known as *design theorists*, advocate an alternative theory known as the *theory of intelligent design* (sometimes abbreviated simply *design* or *design theory*). They have developed design theory in such books as *Darwin's Black Box*,¹⁵ *The Mystery of Life's Origin*,¹⁶ *Mere Creation*,¹⁷ *The Design Inference*,¹⁸ *Darwinism, Design, and Public Education*,¹⁹ *Science and Evidence of Design in the Universe*,²⁰ *The Privileged Planet*,²¹ and *No Free Lunch*²² as well as in articles in scientific and technical journals. Contrary to claims in Pennock's Report, design theorists have developed both a scientific method of design detection and many specific empirical arguments to support their theory.

Developments in the information sciences have recently made possible the articulation of criteria by which intelligently designed systems can be identified by the kinds of patterns they exhibit. In a 1998 book titled *The Design Inference*,²³ published by Cambridge University Press, mathematician and probability theorist William Dembski notes that rational agents often infer or detect the prior activity of other designing minds by the character of the effects they leave behind.²⁴ Archaeologists assume, for example, that rational agents produced the inscriptions on the Rosetta Stone. Insurance fraud investigators detect certain "cheating patterns" that suggest intentional manipulation of circumstances rather than "natural" disasters. Cryptographers distinguish between random signals and those that carry encoded messages. Dembski's work shows that recognizing the

15. MICHAEL J. BEHE, *DARWIN'S BLACK BOX* (1996).

16. CHARLES B. THAXTON, WALTER L. BRADLEY, AND ROGER L. OLSEN, *THE MYSTERY OF LIFE'S ORIGIN* (Philosophical Library, 1984, Lewis & Stanley, 4th ed., 1992 1984).

17. *MERE CREATION: SCIENCE, FAITH & INTELLIGENT DESIGN* (William A. Dembski ed., 1998).

18. WILLIAM A. DEMBSKI, *THE DESIGN INFERENCE: ELIMINATING CHANGE THROUGH SMALL PROBABILITIES* (1998).

19. *DARWINISM, DESIGN & PUBLIC EDUCATION*, Campbell & Meyer, eds. (Michigan State University Press, 2003).

20. Ignatius Press, 2000.

21. Regnery, 2004.

22. Rowman & Littlefield, 2002.

23. Cambridge University Press (1998).

24. *See id. passim*.

activity of intelligent agents constitutes a common and fully rational mode of inference.

More importantly, Dembski's work explicates criteria by which rational agents can recognize the effects of other rational agents, and distinguish them from the effects of natural causes. He argues that systems or sequences that have the joint properties of "high complexity" (or low probability) and "specification" invariably result from intelligent causes, not chance or physical-chemical laws.²⁵ As it turns out, these criteria are equivalent (or "isomorphic") to the notion of specified information or information content. Thus, Dembski's work suggests that "high information content" indicates prior intelligent activity. This theoretical insight comports with common, as well as scientific, experience. Few rational people would, for example, attribute hieroglyphic inscriptions to natural forces such as wind or erosion; instead, they would immediately recognize the activity of intelligent agents. Dembski's work shows why: Our reasoning involves a comparative evaluation process that he represents with a schema he calls "the explanatory filter."²⁶ The filter outlines a formal method by which scientists (as well as ordinary people) decide among three different types of explanations: chance, necessity, and design.²⁷ His "explanatory filter" constitutes, in effect, a scientific method for

25. See DEMBSKI, DESIGN INFERENCE, at 36-66.

Complex sequences are those that exhibit an irregular and improbable arrangement that defies expression by a simple rule or algorithm. A specification, on the other hand, is a match or correspondence between a physical system or sequence and a set of independent functional requirements or constraints. To illustrate these concepts (of complexity and specification), consider the following three sets of symbols:

"inetehnsdyskjldfawqnz,mfdifhsnmcpew,ms.s/a"
 "Time and tide waits for no man."
 "AABABABABABABABABABABABABABAB"

Both the first and second sequences shown above are complex because both defy reduction to a simple rule. Each represents a highly irregular, aperiodic and improbable sequence of symbols. The third sequence is not complex, but is instead highly ordered and repetitive. Of the two complex sequences, only one exemplifies a set of independent functional requirements—i.e., is specified. English has a number of such functional requirements. For example, to convey meaning in English one must employ existing conventions of vocabulary (associations of symbol sequences with particular objects, concepts or ideas) and existing conventions of syntax and grammar (such as "every sentence requires a subject and a verb"). When arrangements of symbols "match" or utilize existing vocabulary and grammatical conventions (i.e., functional requirements), communication can occur. Such arrangements exhibit "specification." The second sequence ("Time and tide waits for no man") clearly exhibits such a match between itself and the preexisting requirements of vocabulary and grammar. It has employed these conventions to express a meaningful idea.

Indeed, of the three sequences above only the second ("Time and tide waits for no man") manifests both the jointly necessary indicators of a designed system. The third sequence lacks complexity, though it does exhibit a simple periodic pattern, a specification of sorts. The first sequence is complex, but not specified as we have seen. Only the second sequence exhibits both complexity and specification. Thus, according to Dembski's theory, only the second sequence, but not the first and third, implicates an intelligent cause. As indeed our intuition tells us. See DEMBSKI, *id.*; see also Stephen C. Meyer, *DNA and the Origin of Life: Information, Specification and Explanation*, in *DARWINISM, DESIGN AND PUBLIC EDUCATION* (Michigan State University Press, Meyer and Campbell, eds., 2003).

26. DEMBSKI, DESIGN INFERENCE, p. 36.

27. See *id.*, pp. 36-66.

detecting the effects of intelligence.

More recently, I have used a different method of design detection by applying a method of reasoning or comparative hypothesis testing known as inference to the best explanation.²⁸ Historical scientists often use this method of reasoning to determine what might have happened in the past to cause present features of the world to have arisen. In particular they use their knowledge of the present cause and effect structure of the world to infer a prior cause which, if present or operative, could have produced some observed effect of interest. Intelligent design can be detected using this method when features are present in artifacts or systems that are known to be produced by intelligent agents and no other cause.

3. *Biological Evidence Supports the Theory of Intelligent Design*

In addition to making use of a formal theory articulating the criteria by which intelligent causes can be detected in the “echo of their effects,” design theorists point to specific empirical evidence of design, both in biology and physics. They argue that biological organisms in particular display distinctive features of intelligently designed systems. Indeed, a growing number of scientists are now willing to consider alternatives to strictly naturalistic origins theories. Many now see especially striking evidence of design in biology, even if much of it is reported by scientists and journals that presuppose a neo-Darwinian perspective.

In 1998, for example, the leading journal *Cell* featured a special issue on “Macromolecular Machines.”²⁹ All cells use complex molecular machines to process information, build proteins, and move materials back and forth across their membranes. Bruce Alberts, President of the National Academy of Sciences, introduced this issue with an article entitled, *The Cell as a Collection of Protein Machines*.³⁰ In it, he stated that

We have always underestimated cells. . . . The entire cell can be viewed as a factory that contains an elaborate network of interlocking assembly lines, each of which is composed of a set of large protein machines. . . . Why do we call the large protein assemblies that underlie cell function protein *machines*? Precisely because, like machines invented by humans to deal efficiently with the macroscopic world, these

28. S.C. Meyer, “The Origin of Biological Information and the Higher Taxonomic Categories,” *Proceedings of the Biological Society of Washington*, 117(2) (2004): 213-239.

29. See Review, *Macromolecular Machines*, 92 CELL 291 (1998).

30. See Bruce Alberts, *The Cell as a Collection of Protein Machines: Preparing the Next Generation of Molecular Biologists*, 92 CELL 291 (1998).

protein assemblies contain highly coordinated moving parts³¹

Alberts notes that molecular machines strongly resemble machines designed by human engineers.³²

Although, as an orthodox neo-Darwinist, he denies any role for actual, as opposed to apparent, design in the origin of these systems.³³

In recent years, however, some scientists have formulated a formidable challenge to the neo-Darwinian view. For example, in *Darwin's Black Box*, Lehigh University biochemist Michael Behe shows that neo-Darwinists have failed to explain the origin of complex molecular machines in living systems.³⁴ Behe examines, among other systems, the acid-powered rotary engines that turn the whiplike flagella of certain bacteria.³⁵ He shows that the intricate machinery in this molecular motor—including a rotor, a stator, O-rings, bushings, and a drive shaft—requires the coordinated interaction of approximately forty complex protein parts.³⁶ The absence of any one of these proteins would result in the complete loss of motor function. This fact poses a severe problem for the Darwinian mechanism. Natural selection selects functionally advantageous systems. Yet the flagellar motor has no function until *after* all forty of its necessary parts have independently self-assembled. Thus, natural selection can preserve the motor once it works, but it can do nothing to construct the motor in the first place.

Thus, Behe insists that Darwinian mechanisms cannot account for the origin of molecular motors and other such “irreducibly complex” systems that require the coordinated interaction of multiple, independent protein parts.³⁷ To emphasize his point, Behe conducted a literature search of relevant technical journals.³⁸ He found a complete absence of gradualistic neo-Darwinian explanations for the origin of the systems and motors that he discusses.³⁹ Behe concludes that neo-Darwinists have not explained nor, in most cases, even attempted to explain, how the appearance of

31. *Ibid.*, p. 291.

32. *Ibid.*

33. *Ibid.*

34. BEHE, *DARWIN'S BLACK BOX*, at 179.

35. *See id.*

36. *See id.* at 69-73.

37. *See id.* at 3-164.

38. *See id.* at 165-86.

39. *See id.* at 179. *See also* Behe, *Answering Scientific Criticisms of Intelligent Design*, in *SCIENCE AND EVIDENCE OF DESIGN IN THE UNIVERSE* 121 (2000).

design in “irreducibly complex” systems arose naturally.⁴⁰

Instead, he notes that we know of only one cause sufficient to produce functionally integrated, irreducibly complex systems—intelligence.⁴¹ Whenever we encounter irreducibly complex systems and we know how they arose, invariably a designer played a causal role. Thus, Behe concludes on the basis of our knowledge of present cause and effect relationships (in accord with the standard uniformitarian method employed in the historical sciences) that the molecular machines and complex systems we observe in cells probably resulted from an intelligent cause.⁴² In brief, molecular motors *appear* designed because they *were* designed.

The publication of Behe’s book in 1996 generated international acclaim and critique in over eighty book reviews. Behe’s work has been cited favorably by other scientists in peer-reviewed scientific articles.⁴³ Other scientists have criticized his work and offered an alternative hypothesis for the origin of irreducibly complex structures.⁴⁴ The biologist Ken Miller, for example, theorized that complex structures like the bacterial flagellum might have developed gradually through the “co-option” of simpler subsidiary structures. Behe and Miller have debated this issue recently in a peer-edited anthology of scientific essays entitled *DEBATING DESIGN*,⁴⁵ published by the Cambridge University Press in 2004. Dr. Scott Minnich, a microbiologist who works on the bacterial flagellum, has recently defended Behe’s argument by critiquing Miller’s co-option hypothesis in a paper given at a scientific conference, the proceedings of which were published with Wessex Institute of

40. Since the publication of Behe’s book in 1996, some critics, notably biologist Ken Miller, have argued that some recent (post-1996) scientific articles do suggest plausible ways of assembling irreducibly complex systems in a gradual Darwinian fashion. Behe has responded to these claims. He has argued that (a) the papers that Miller cites often do not make the claims that Miller uses them to make and (b) those Darwinian scenarios that Miller (and others) do offer lack sufficient biochemical plausibility and specificity to solve the problem of the origin of Darwin. For Behe’s responses to Miller, see Michael J. Behe *Answering Scientific Criticisms of Intelligent Design* in *SCIENCE AND EVIDENCE OF DESIGN IN THE UNIVERSE* 121 (2000); see also *Irreducible Complexity and the Evolutionary Literature: Response to Critics*, archived at <http://www.discovery.org/scripts/viewDB/index.php?command=view&id=443>.

41. See *id.* at 187-231.

42. See *id.* at 187-208.

43. W.-E. Lönnig & H. Saedler, *Chromosome Rearrangements and Transposable Elements*, *ANNUAL REVIEW OF GENETICS*, 36 (2002): 389-410.

44. KENNETH MILLER, *FINDING DARWIN’S GOD* (1999).

45. See Appendix A.

Technology Press.⁴⁶

Other scientists see evidence for intelligent design in other features of the living world. Consider the case of Professor Dean Kenyon. For nearly twenty years, Professor Kenyon was a leading evolutionary theorist who specialized in origin-of-life biology. In 1969 he coauthored *Biochemical Predestination*,⁴⁷ a book that defined evolutionary thinking on the origin-of-life for over a decade. Kenyon's theory attempted to show how complex bio-molecules such as proteins and DNA might have "self-organized" via strictly chemical forces.⁴⁸ Yet as Kenyon reflected more on developments in molecular biology about the complexity of living things, he began to question whether undirected chemistry could really produce the information-rich molecules found even in "simple" cells. Studies of the DNA revealed that it functions in much the same way as a machine code or a text in a book. As Richard Dawkins notes, "The machine code of the genes is uncannily computer like."⁴⁹ Or, as software innovator Bill Gates notes, "DNA is like a computer program, but far, far more advanced than any software we've ever created."⁵⁰ Studies in molecular biology and information theory have shown that the assembly instructions inscribed along the spine of DNA display the characteristic hallmarks of intelligently encoded information: both the complexity and specificity of function that, according to Dembski's theory, indicate design.⁵¹ As a result of this evidence, Kenyon and many other scientists (notably Charles Thaxton, Walter Bradley, and Roger Olsen), as well as philosophers of science such as William Dembski and I, have concluded that the "specified complexity" or high information content of DNA—like the information in a computer program, an ancient scroll, or in this article—had an intelligent source.⁵²

46. Scott Minnich & Stephen C. Meyer, *Genetic Analysis of Coordinate Flagellar and Type III Regulatory Circuits in Pathogenic Bacteria*, in *DESIGN AND NATURE II: COMPARING DESIGN IN NATURE WITH SCIENCE AND ENGINEERING*, Collins and Brebbia, eds., (Wessex Institute of Technology, 2004).

47. DEAN H. KENYON & GARY STEINMAN, *BIOCHEMICAL PREDESTINATION* (1969).

48. *See id.* at 36, 219-69.

49. RICHARD DAWKINS, *RIVER OUT OF EDEN* 17 (1995).

50. BILL GATES, *THE ROAD AHEAD* 228 (1996).

51. *See* Sahotra Sarkar, *Biological Information: A Skeptical Look at Some Central Dogmas of Molecular Biology*, in *THE PHILOSOPHY AND HISTORY OF MOLECULAR BIOLOGY: NEW PERSPECTIVES* 191 (Sahotra Sarkar ed., 1996).

52. *See* Stephen C. Meyer, *DNA by Design: An Inference to the Best Explanation for the Origin of Biological Information*, 1 *RHETORIC AND PUBLIC AFFAIRS* 519 (1998); Stephen C. Meyer, *The Explanatory Power of Design*, *MERE CREATION* (William A. Dembski, ed.), 113-47 (1998).

In recent years the fossil record has also provided new support for the design hypothesis. Fossil studies reveal a “biological big bang” near the beginning of the Cambrian period 530 million years ago.⁵³ At that time roughly forty separate major groups of organisms or “phyla” (including most all the basic body plans of modern animals) emerged suddenly without evident precursors.⁵⁴ Although neo-Darwinian theory requires vast periods of time for the step-by-step development of new biological organs and body plans, fossil finds have repeatedly confirmed a pattern of explosive appearance and prolonged stability in living forms.⁵⁵ As I recently argued in an extensive scientific review article published in the peer-reviewed *Proceedings of the Biological Society of Washington*,⁵⁶ the emergence of the biological information needed to build these new organisms points strongly to intelligent design. As the information theorist Henry Quastler once observed, “information habitually arises from conscious activity.”⁵⁷ Thus, I argue that the large infusion of biological information that arises in the Cambrian fossil record points strongly to intelligent design. Moreover, the fossil record also shows a “top-down” hierarchical pattern of appearance in which major structural themes or body plans emerge before minor variations on those themes.⁵⁸ Not only does this pattern directly contradict the “bottom-up” pattern predicted by neo-Darwinism, but as I have argued with paleontologist Marcus Ross, philosopher of biology Paul Nelson and University of San Francisco marine paleobiologist Paul Chien, in a 20,000 word scientific review article,⁵⁹ the pattern in the fossil record strongly resembles the pattern evident in the history of human technological design.⁶⁰ Thus, we argue that this pattern suggests actual (i.e., intelligent) design as the best explanation for evidence in the fossil record.⁶¹

53. See Meyer, S. C., Ross, M., Nelson, P. & P. Chien, *The Cambrian Explosion: Biology's Big Bang*, DARWINISM, DESIGN, & PUBLIC EDUCATION, edited by John Angus Campbell and Stephen C. Meyer (Michigan State University Press, 2003), pp. 323-402.

54. See *id.*

55. See *id.*

56. S.C. Meyer, “The Origin of Biological Information and the Higher Taxonomic Categories,” *Proceedings of the Biological Society of Washington*, 117(2) (2004): 213-239.

57. HENRY QUASTLER, *THE EMERGENCE OF BIOLOGICAL ORGANIZATION* (1964), at 16.

58. Meyer, Ross, Nelson, & Chien, *The Cambrian Explosion: Biology's Big Bang*, DARWINISM, DESIGN, & PUBLIC EDUCATION, Campbell and Meyer, eds., (Michigan State University Press, 2003), pp. 323-402.

59. *Ibid.*

60. *Ibid.*

61. *Ibid.*

Other scientists now see evidence of design in the fine-tuning in the constants of physics,⁶² the delicate balance of our terrestrial environment,⁶³ the information processing system of the cell, and even in the phenomenon known as “homology” (evidence previously thought to provide unequivocal support for neo-Darwinism).⁶⁴ Design theorists have begun to marshal a wide array of empirical evidence in support of their perspective, thus challenging standard evolutionary theories for the origin and development of life across a variety of sub-disciplines within biology and other sciences.⁶⁵

4. *There is, contra Forrest, Peer-reviewed and Peer-edited Scientific Literature Supporting the Theory of Intelligent Design.*

Critics of the theory of intelligent design often make claims that give the false impression that advocates of the theory have failed to publish their work in appropriate academic or scientific venues. For example, in a recent USA Today article, Barbara Forrest was quoted as saying that “[design theorists] aren't published because they don't have any scientific data.”⁶⁶ Similarly, in her expert witness Report, Barbara Forrest claims, “There are no peer-reviewed ID articles in which ID is used as a biological theory in mainstream scientific databases such as MEDLine.” Dr. Forrest’s carefully qualified statement gives a false impression. Scientists and philosophers advocating the theory of intelligent design have developed their theory and the empirical case for it in peer-reviewed scientific books published by both trade presses⁶⁷ and by prestigious university presses.⁶⁸ They have also published scientific articles advancing the case for intelligent design in peer-edited or peer-

62. See, generally, William Lane Craig, *God, Creation and Mr. Davies*, 37 BRIT. J. FOR THE PHILOSOPHY OF SCIENCE 163 (1986); William Lane Craig, *Barrow and Tipler on the Anthropic Principle vs. Divine Design*, 38 BRIT. J. FOR THE PHILOSOPHY OF SCIENCE 389 (1988).

63. GUILLERMO GONZALEZ AND JAY W. RICHARDS, *THE PRIVILEGED PLANET: HOW OUR PLACE IN THE COSMOS IS DESIGNED FOR DISCOVERY* (Regnery Publishing, 2004).

64. See Jonathan Wells & Paul Nelson, *Homology: A Concept in Crisis*, ORIGINS & DESIGN, Fall 1997, at 12 (arguing that “naturalistic mechanisms proposed to explain homology do not fit the evidence”).

65. *Ibid.*

66. USA Today (March 23, 2005).

67. MICHAEL J. BEHE, *DARWIN'S BLACK BOX* (1996); Guillermo Gonzalez and Jay W. Richards, *The Privileged Planet: How Our Place in the Cosmos is Designed for Discovery* (Regnery Publishing, 2004); CHARLES B. THAXTON, WALTER L. BRADLEY, AND ROGER L. OLSEN, *THE MYSTERY OF LIFE'S ORIGIN* (1984).

68. WILLIAM A. DEMBSKI, *THE DESIGN INFERENCE: ELIMINATING CHANGE THROUGH SMALL PROBABILITIES* (1998); John Angus Campbell and Stephen C. Meyer, eds., *DARWINISM, DESIGN, & PUBLIC EDUCATION* (Michigan State University Press, 2003).

reviewed scientific books published by prestigious university presses,⁶⁹ and in scientific conference proceedings published by prestigious university presses and trade presses.⁷⁰ Finally, advocates of intelligent design have published work advancing their theory, either directly or indirectly, in peer-reviewed philosophical journals,⁷¹ and in peer-reviewed scientific journals.⁷²

Appendix A to this Report lists books and articles advancing the theory of intelligent design that have appeared in prominent trade presses or in peer-reviewed or peer-edited publications. This list also provides brief summaries of the content of these books and articles.

Some critics of design have attempted to discredit the theory because its advocates have published their case primarily in books rather than in scientific articles. Though this argument is now somewhat dated, because more scientific articles are now being published to advance the theory, it is worth addressing briefly.

Most of the great ideas in the history of science first appeared, not in technical journals and monographs, but in books. In 1543, Nicholas Copernicus proposed his heliocentric theory of the solar system in a book, *On the Revolutions of the Heavenly Spheres*. The book changed our view of the structure of the universe forever. A century later, Galileo Galilei wrote several books in defense of Copernicus's thesis. A few decades later, in 1687, Isaac Newton published his *Principia*, one of the greatest scientific treatises every written.⁷³ Then, in 1859, Charles Darwin published his *Origin*

69. See the five articles advancing the case for the theory of intelligent published in DARWINISM, DESIGN, AND PUBLIC EDUCATION, and the four articles published in DEBATING DESIGN, listed in Appendix A.

70. Scott Minnich & Stephen C. Meyer, *Genetic Analysis of Coordinate Flagellar and Type III Regulatory Circuits in Pathogenic Bacteria*, in DESIGN AND NATURE II: COMPARING DESIGN IN NATURE WITH SCIENCE AND ENGINEERING, Collins and Brebbia, eds., (Wessex Institute of Technology, 2004); William Dembski, ed., MERE CREATION: SCIENCE, FAITH, AND INTELLIGENT DESIGN (1998).

71. William Lane Craig, *God, Creation and Mr. Davies*, 37 BRIT. J. FOR THE PHILOSOPHY OF SCIENCE 163 (1986); William Lane Craig, *Barrow and Tipler on the Anthropic Principle vs. Divine Design*, 38 BRIT. J. PHILOSOPHY OF SCIENCE 389 (1988); Michael J. Behe, *Self-Organization and Irreducibly Complex Systems: A Reply to Shanks and Joplin*, PHILOSOPHY OF SCIENCE 67:155-162 (March 2000).

72. S.C. Meyer, "The Origin of Biological Information and the Higher Taxonomic Categories," *Proceedings of the Biological Society of Washington*, 117(2) (2004): 213-239.; Jonathan Wells, "Do Centrioles Generate a Polar Ejection Force? *Rivista di Biologia/Biology Forum* 98 (2005): 37-62; M.J. Behe and D.W. Snoke, "Simulating Evolution by Gene Duplication of Protein Features That Require Multiple Amino Acid Residues," *Protein Science*, 13 (2004): 2651-2664; W.-E. Lönnig & H. Saedler, "Chromosome Rearrangements and Transposable Elements," *Annual Review of Genetics*, 36 (2002): 389-410.

73. Sir Isaac Newton's *Mathematical Principles of Natural Philosophy and His System of the World* 543, 544 (Florian Cajori ed. & Andrew Motte trans., 1946). Newton suggested that the stability of the planetary system depended not only upon the regular action of universal gravitation, but also upon the very precise initial positioning of the planets and comets in relation to the sun. As he explained:

Though these bodies may, indeed, persevere in their orbits by the mere laws of gravity, yet they could by no means have at first derived the regular position of the orbits themselves from those laws.... [Thus] this most beautiful system of the sun, planets, and comets, could

of the Species. This book was published in a prominent trade press, not an academic journal; given the perspective of most biologists of the time, had it been subjected to peer review it likely would have been rejected. If the complaint about the theory of intelligent design and “peer reviewed” technical articles were applied consistently, then many of the foundational works of science would be deemed unscientific.

Anyone who understands the role that technical journals play in science will understand why this is so. Science journals are a highly specialized and conservative genre. They are designed to explore and fill out a scientific research program that is already well established. They are part of what philosopher of science Thomas Kuhn called “normal science.”⁷⁴ That is their virtue. It is also their vice, since it means that new and revolutionary ideas in science are very unlikely to appear first in their pages. If the history of science is any indication, then we should expect most of the initial work in any fundamentally new scientific perspective to appear first in books.

And this is precisely the pattern with publication about the theory of intelligent design. In the last decade or so, a number of new evidence-based arguments for the theory have made their initial appearance in books. More recently, scientific articles have begun to appear, elucidating the theory in more detail.

B. The Failure of Demarcation Arguments

Just as there are good practical reasons for affirming the scientific character of the theory of intelligent design, there are no good in principle reasons for refusing to do so. In particular, (1) philosophers of science have generally abandoned the use of rigid demarcation criteria to make such determinations; (2) specific demarcation criteria applied to the origins question fail to distinguish design from its competitors; (3) Pennock's application of the demarcation criteria fail to disqualify the theory of intelligent design; and (4) there are further problems with the principle of

only proceed from the counsel and dominion of an intelligent and powerful being.
Or as he wrote in *The Opticks*:

How came the Bodies of Animals to be contrived with so much Art, and for what ends were their several parts? Was the Eye contrived without Skill in Opticks, and the Ear without Knowledge of Sounds?... And these things being rightly dispatch'd, does it not appear from phaenomena that there is a Being incorporeal, living, intelligent, omnipresent...
SIR ISAAC NEWTON, *THE OPTICKS* 369 Book 3, Part 1, Query 28 (1952).

74. THOMAS KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* (3d. Ed., University of Chicago Press, 1996).

methodological naturalism.

1. *Scientists Have Abandoned the Search for Rigid Demarcation Criteria Such as Those Pennock Employs*

In response to the affirmative case for intelligent design, critics of design theory frequently claim, as Pennock does, that the very notion of “intelligent design” is inherently unscientific—that design theory does not qualify as science according to established definitions of the term. To justify this claim critics often cite various definitional or demarcation criteria that purport to define science and distinguish it from pseudoscience, metaphysics, or religion.⁷⁵ These kinds of arguments have previously played an important role in deciding the scientific, and consequently legal, status of “creation science.” (Moreover, Pennock uses them to cast doubt on the scientific status of the theory of intelligent design, which Pennock mistakenly equates with “creationism,” by his repeated use of the pejorative term, “intelligent design creationism.” I have elsewhere explained why these two theories are not the same—in content, method, and for purposes of the law.⁷⁶) In any case, attempts to define science normatively by reference to rigid demarcation criteria (of the kind that Pennock employs) have failed within the philosophy of science, the relevant discipline for adjudicating questions about the nature and definition of science.

Demarcation arguments made their first appearance in federal court in 1982, when a federal judge adopted a five-point definition of science as part of his finding that a law requiring Arkansas public schools to teach “creation science” alongside standard neo-Darwinian theory was unconstitutional.⁷⁷ While, as noted, there are decisive differences between the theory of intelligent design and creation science, critics of design theory often rely upon the *McLean* criteria⁷⁸ to establish definitional or methodological norms in an attempt to disqualify the theory of intelligent design from

75. “Explanations employing non-naturalistic or supernatural events, whether or not explicit reference is made to a supernatural being, are outside the realm of science and not part of a valid science curriculum.” NATIONAL ACADEMY OF SCIENCE, *TEACHING ABOUT EVOLUTION AND THE NATURE OF SCIENCE* 127 (1998).

76. For the distinction between intelligent design theory and creation science, see DeWolf, Meyer & DeForrest, *Teaching the Origins Controversy: Science, Or Religion, or Speech?* 2000 UTAH LAW REVIEW 39, pp. 93-95.

77. See *McLean v. Arkansas Bd. of Educ.*, 529 F. Supp. 1255, 1267 (E.D. Ark. 1982) (“[T]he essential characteristics of science are: (1) It is guided by natural law; (2) It has to be explanatory by reference to natural law; (3) It is testable against the empirical world; (4) Its conclusions are tentative, i.e., are not necessarily the final word; and (5) It is falsifiable.”).

78. See *id.*

consideration as a scientific theory.

In *McLean*, Judge William Overton ruled that an Arkansas law requiring the teaching of “creation science” in public schools violated the First Amendment’s establishment clause.⁷⁹ He based his decision not only on the Establishment Clause, but upon a finding that so-called “creation science” does not qualify as science.⁸⁰ Indeed, he reasoned that because creation science does not qualify as science it constituted religion.⁸¹ In making his determination, Judge Overton relied upon the expert testimony of the Darwinian philosopher of science Michael Ruse.⁸² In his expert testimony, Ruse and other expert witnesses asserted a five-point definition of science that provided allegedly normative criteria for determining whether a theory qualifies as scientific.⁸³ Any theory, according to Ruse, which failed to meet these five criteria could not be considered to be “scientific.”⁸⁴ According to Ruse, for a theory to be scientific it must be:

- (1) guided by natural law;
- (2) explanatory by natural law;
- (3) testable against the empirical world;
- (4) tentative in its conclusions; and
- (5) falsifiable.⁸⁵

Ruse further testified that creation science—in part because it invoked the singular action of a creator as the cause of certain events in the history of life—could never meet these criteria.⁸⁶ Thus, he

79. See *id.* at 1258, 1264. The court specifically found that the Arkansas law “was passed with the specific purpose . . . of advancing religion.” *Id.* at 1264. This placed the law directly in conflict with the First Amendment’s establishment clause under the *Lemon* test. See *id.* For a statute to pass constitutional muster under *Lemon* it must have a secular legislative purpose, it cannot either advance or inhibit religion, and it must not foster an excessive entanglement between government and religion. See *Lemon v. Kurtzman*, 403 U.S. 602, 612-13 (1971); *Stone v. Graham*, 449 U.S. 39, 40 (1980). A violation of any of the prongs of the *Lemon* test results in a violation of the Establishment Clause. See *McLean*, 529 F. Supp. at 1258. The court in *McLean* found that the Arkansas law’s purpose was to advance religion in the public schools in violation of *Lemon*’s first prong. See *id.* at 1264. The court also found that the Arkansas law would result in an impermissible entanglement with religion, violating the third prong of *Lemon*. See *id.* at 1272.

80. See *McLean*, 529 F. Supp. at 1267-72. The court’s language was unambiguous: “Section 4(a) [of the Arkansas Act] lacks legitimate educational value because ‘creation science’ as defined in that section is simply not science.” *Id.* See generally Robert M. Gordon, Note, *McLean v. Arkansas Board of Education: Finding the Science in “Creation Science,”* 77 NW. U. L. REV. 374 *passim* (1982) (discussing court’s finding that creation science is unscientific).

81. See *McLean*, 529 F. Supp. at 1272.

82. See *id.* at 1267.

83. See *id.*

84. See *id.* In the court’s words, these five points are the “essential characteristics of science.” *Id.* at 1267.

85. See *id.*

86. See *id.*

concluded that creationism might be true, but it could never qualify as science.⁸⁷ Judge Overton ultimately agreed, adopting Ruse's five demarcation criteria as part of his opinion.⁸⁸

Although the case was in some ways superseded by the subsequent ruling of the United States Supreme Court in *Edwards v. Aguillard*,⁸⁹ the *McLean* case, and the philosophy of science that underwrites it, poses an implied challenge to the scientific status of all theories of origin (including the theory of intelligent design) that invoke singular, intelligent causes as opposed to strictly material causes.⁹⁰

Notwithstanding the favorable reception that Michael Ruse enjoyed in Judge Overton's courtroom, many prominent philosophers of science, including Larry Laudan and Philip Quinn⁹¹ (neither of whom supported creation science's empirical claims), soon repudiated Ruse's testimony on the grounds that, as Laudan argued, it "canoniz[ed] a false stereotype of what science is and how it works."⁹² These philosophers of science insisted that Ruse's testimony seriously misrepresented contemporary thinking in the philosophy of science about the status of the demarcation problem.⁹³ Indeed, it now seems clear for several reasons that the philosophy of science provides no grounds for disqualifying non-materialistic alternatives (in particular the theory of intelligent design) to Darwinism as inherently "unscientific."

First, as Laudan noted, many philosophers of science have generally abandoned attempts to define science by reference to abstract demarcation criteria.⁹⁴ Indeed, they have found it notoriously difficult to define science generally via the kind of rigid methodological criteria that Ruse and the court promulgated in the *McLean* case—in part because proposed demarcation criteria have

87. *See id.*

88. *See id.*

89. 482 U.S. 578 (1987).

90. *See* NATIONAL ACADEMY OF SCIENCE, TEACHING ABOUT EVOLUTION AND THE NATURE OF SCIENCE (1998).

91. *See* Larry Laudan, *Science at the Bar—Causes for Concern*, in BUT IS IT SCIENCE? 351, 355 (Michael Ruse ed., 1988) ("It simply will not do for the defenders of science to invoke philosophy of science when it suits them . . . and to dismiss it as 'arcane' and 'remote' when it does not."); Philip Quinn, *The Philosopher of Science as Expert Witness*, in BUT IS IT SCIENCE? 367, 384 (Michael Ruse ed., 1988) (criticizing expert testimony in *McLean* as "fallacious" and not representative of "settled consensus of opinion in the relevant community of scholars").

92. Laudan, *Science*, at 355.

93. *See id.*; Quinn, at 367-85.

94. *See* Laudan, *Science*, at 354-55.

inevitably fallen prey to death by counterexample.⁹⁵ Well established scientific theories often lack some of the presumably necessary features of true science (e.g., falsifiability, observability, repeatability, use of law-like explanation, etc.), while many poorly supported, disreputable, or “crank” ideas often meet some of these same criteria.

Consider, for example, the criteria of falsifiability and tentativeness, two key and related litmus tests in the 1981 *McLean* trial.⁹⁶ Although Ruse asserts that all truly scientific theories are held tentatively by their proponents and are readily falsifiable by contradictory evidence, the history of science tells a very different story. As Imre Lakatos, one of the premier historians and philosophers of science of the twentieth century, showed in the 1970s, some of the most powerful scientific theories have been constructed by those who stubbornly refused to reject their theories in the face of anomalous data.⁹⁷ For example, on the basis of his theory of universal gravitation, Sir Isaac Newton made a number of predictions about the position of planets that did not materialize.⁹⁸ Nevertheless, rather than rejecting the notion of universal gravitation he refined his “auxiliary assumptions” (e.g., the assumption that planets are perfectly spherical and influenced only by gravitational force) and left his core theory in place.⁹⁹ As Lakatos showed, the explanatory flexibility of Newton’s theory in the face of apparently falsifying evidence turned out to be one of its greatest strengths.¹⁰⁰ Such flexibility emphatically did not compromise universal gravitation’s “scientific status” as Ruse’s definition of science would imply.¹⁰¹

On the other hand, the history of science is littered with the remains of failed theories that have been falsified, not by the air-tight disproof of a single anomaly, but by the judgment of the scientific community concerning the preponderance of data.¹⁰² Are such falsified, and therefore falsifiable, theories (e.g., the flat earth, phlogiston, geocentrism, flood geology, etc.) more scientific

95. *See id.* at 353-54.

96. *McLean v. Arkansas Bd. of Educ.*, 529 F. Supp. 1255 (E.D. Ark. 1982).

97. *See* Imre Lakatos, *Falsification and the Methodology of Scientific Research Programmes*, in *SCIENTIFIC KNOWLEDGE: BASIC ISSUES IN THE PHILOSOPHY OF SCIENCE* 173 (Janet A. Kouvray ed., 1987) (presenting scientific progress as rational process rather than religious conversions).

98. *See id.*

99. *See id.* at 175.

100. *See id.* at 192.

101. *See* Lakatos, *Falsification*, at 175.

102. *See id. passim.*

than successful theories (such as Newton's was in, say, 1750) that possess wide-ranging explanatory power?

As a result of such contradictions, most contemporary philosophers of science have come to regard the question, "what distinguishes science from non-science," as both intractable and uninteresting. Instead, philosophers of science have increasingly realized that the real issue is not whether a theory is "scientific" according to some abstract definition, but whether a theory is true, or warranted by the evidence. As Laudan explains, "If we would stand up and be counted on the side of reason, we ought to drop terms like 'pseudo-science' . . . they . . . do only emotive work for us."¹⁰³ As Martin Eger has summarized, "[d]emarcation arguments have collapsed. Philosophers of science don't hold them anymore. They may still enjoy acceptance in the popular world, but that's a different world."¹⁰⁴

2. *Specific Demarcation Criteria Applied to the Origins Question Fail to Distinguish Design from Its Competitors*

Even if one assumes for the sake of argument that criteria could be found to demarcate science in general from non-science in general, the specific demarcation criteria used by Ruse in the *McLean* case (and by others) have proven utterly incapable of discriminating the scientific status of materialistic and non-materialistic origins theories.¹⁰⁵ Laudan noted, for example, that Judge Overton's opinion made much of creation science's inability to be tested or falsified.¹⁰⁶ Yet, as Laudan argues, the claim that:

Creationism is neither falsifiable nor testable is to assert that Creationism makes no empirical assertions whatever. That is surely false. Creationists make a wide range of testable assertions about matters of fact. Thus, as Judge Overton himself grants (apparently without seeing its implications), the creationists say that the earth is of very recent origin . . . they argue that most of the geological features of the earth's surface are diluvial in character . . . they assert the limited variability of species. They are committed to the view that, since animals and man were created at the same time, the human fossil record must be paleontologically co-extensive with the record of

103. Larry Laudan, *The Demise of the Demarcation Problem*, in BUT IS IT SCIENCE? 337, 349 (Michael Ruse ed., 1988).

104. John Buell, *Broaden Science Curriculum*, DALLAS MORNING NEWS, March 10, 1989, at A21 (quoting unidentified "authority").

105. See Laudan, *Science*, at 354.

106. See *id.* at 352.

lower animals.¹⁰⁷

Laudan notes that, though creation scientists “are committed to a large number of factual . . . claims,” available evidence contradicts their empirical claims.¹⁰⁸ As he explains, “no one has shown how to reconcile such claims with the available evidence—evidence which speaks persuasively to a long earth history, among other things. In brief, these claims are testable, they have been tested, and they have failed those tests.”¹⁰⁹

Yet, Laudan notes, if creationist arguments have been shown false by empirical evidence (as Ruse and other expert witnesses at the Arkansas trial no doubt believed), then creation science must be falsifiable.¹¹⁰ But if it is falsifiable, then by Ruse’s own criterion, it must qualify as scientific.

Similar problems have afflicted other demarcation criteria. For example, insofar as both creationist and evolutionary theories make historical claims about past causal events, both theories offer causal explanations that are not explained by natural law. The theory of common descent, a central thesis of the *Origin of Species*, does not explain by natural law. Common descent explains by postulating hypothetical historical events (and a pattern of events) which, if actual, would explain a variety of presently observed data.¹¹¹ The theory of common descent makes claims about what happened in the past—namely that unobserved transitional organisms existed—forming a genealogical bridge between presently existing life forms.¹¹² Thus, on the theory of common descent, a postulated pattern of events, not a law, does the main explanatory work. Similarly, as Laudan notes, scientists often make “existence claims” about past events or present processes without knowing the natural laws on which they depend.¹¹³ As he notes, “Darwin took himself to have established the existence of [the mechanism of] natural selection almost a half century before geneticists were able to lay out the laws of heredity on which natural selection depended.”¹¹⁴ Thus, Ruse’s second demarcation criterion would require, if applied consistently, classifying *both* creation science and

107. *Id.*

108. *Id.*

109. *Id.*

110. *See id.* at 352-53.

111. *See* CHARLES DARWIN, ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION 411-34 (photo. reprint, Harvard Univ. Press 1964) (1859).

112. *See id.*

113. Laudan, *Science*, at 354.

114. *Id.*

classical Darwinism (as well as much of neo-Darwinism) as unscientific. As Laudan notes, If we took the *McLean* Opinion criterion seriously, we should have to say that . . . Darwin [was] unscientific; and, to take an example from our own time, it would follow that plate tectonics is unscientific because we have not yet identified the laws of physics and chemistry which account for the dynamics of crustal motion.¹¹⁵

Third, analyses of the demarcation problem have suggested that naturalistic and non-naturalistic origins theories (including both Darwinism and design theory) are “methodologically equivalent,” both in their ability to meet various demarcation criteria and as historical theories of origin. As noted above, Laudan’s critique suggests that when the specific demarcation criteria promulgated in the *McLean* case are applied rigidly, they disqualify both Darwinism and various non-materialistic alternatives.¹¹⁶ Yet as his discussion of falsification suggests, if certain criteria are applied more liberally, then both theories may qualify as scientific. My own work on the demarcation issue has confirmed and amplified Laudan’s analysis.¹¹⁷ I have shown that philosophically neutral criteria do not exist that can define science narrowly enough to disqualify theories of creation or design without also disqualifying Darwinism and/or other materialistic evolutionary theories on identical grounds.¹¹⁸ Either science will be defined so narrowly as to disqualify both types of theory, or science must be defined more broadly, and the initial reasons for excluding opposing theories will evaporate. Thus, materialistic and non-materialistic origins theories appear to be methodologically equivalent with respect to a wide range of demarcation criteria—that is, both appear equally scientific or equally unscientific provided the same methodological criteria are used to adjudicate their scientific status (and provided philosophically neutral criteria are used to make such assessments).

Indeed, recent work on the historical sciences suggests deep methodological and logical

115. *Id.*

116. *See id.*

117. *See, e.g.,* Stephen C. Meyer, *The Demarcation of Science and Religion*, in *THE HISTORY OF SCIENCE AND RELIGION IN THE WESTERN TRADITION: AN ENCYCLOPEDIA* 17, 22 (Gary Ferngren et al., eds., 2000) (“[I]nsofar as both creationist and evolutionary theories constitute historical theories about past causal events, neither explains exclusively by reference to natural law.”); Stephen C. Meyer, *The Nature of Historical Science and the Demarcation of Design and Descent*, in *4 FACETS OF FAITH AND SCIENCE* 91 (Jitse M. van der Meer ed., 1996) [hereinafter Meyer, *Demarcation*]; Stephen C. Meyer, *The Methodological Equivalence of Design & Descent: Can There Be a Scientific “Theory of Creation?”*, in *THE CREATION HYPOTHESIS: SCIENTIFIC EVIDENCE FOR AN INTELLIGENT DESIGNER* 67, 102 (J.P. Moreland ed., 1994) (“The exclusion of one of the logically possible programs of origins research by assumption . . . seriously diminishes the significance of any claim to theoretical superiority by advocates of a remaining group.”).

118. *See* Laudan, *Science*, at 354.

similarities between various origins theories. Philosopher of biology Elliot Sober has argued that both classical design arguments and the Darwinian argument for descent with modification constitute attempts to make inferences to the best explanation.¹¹⁹ My work in the philosophy of science has shown that both Darwinism and design theory attempt to answer characteristically historical questions: both may have metaphysical implications or overtones; both employ characteristically historical forms of inference, explanation, and testing; and both are subject to similar epistemological limitations.¹²⁰

3. *Pennock's Specific Demarcation Criteria Fail to Disqualify the Theory of Intelligent Design*

Despite the well-known difficulties with demarcation arguments, Pennock claims that excluding the theory of intelligent design from consideration as a scientific hypothesis “is entirely reasonable” given the methodological requirements of scientific investigation. In his report, Pennock claims specifically that the theory of intelligent design fails to meet a key requirement of the scientific method, namely, testability. He claims the design hypothesis is not testable for three reasons. First, he claims that it is not testable because the theory of intelligent design fails to explain phenomena by reference to observable entities (or, perhaps, because it is not based upon observable evidence—Pennock is not entirely clear). Second, he claims the theory of intelligent design is not testable because it posits an explanation that does not refer to causal laws (or law-like processes) that would allow it to be tested by isolating variables under controlled laboratory conditions. Third, Pennock argues that the theory of intelligent design is not testable because it invokes a supernatural being that could in principle cause any event or situation whatsoever, thus making the design hypothesis consistent with all possible states of affairs and refutable by none.

I will examine each of these three arguments in order.

First, Pennock seems to claim that the unobservable character of a designing intelligence (which he assumes is necessarily supernatural) renders it inaccessible to empirical investigation and

119. See ELLIOTT SOBER, *PHILOSOPHY OF BIOLOGY* 27, 56 (1993) (finding that creationism and Darwinism both use characteristic approaches and techniques to attempt to explain certain phenomena).

120. See Meyer, *Demarcation*, at 91-130; Meyer, *Equivalence*, at 99 (“[T]he conjunction of the methodological equivalence of design and descent and the existence of a convention that regards descent as scientific implies that design should—by that same convention—be regarded as scientific too.”).

thus precludes the possibility of testing the theory of intelligent design. As he explains, “science operates by empirical principles of observational testing; hypotheses must be confirmed or disconfirmed by reference to intersubjectively accessible empirical data.” (p. 20) Or as he puts it, “Scientific models must be judged on the natural grounds of evidence. . .” Pennock denies that the theory of intelligent design meets these criteria. Thus, Pennock conjoins two demarcation criteria: “observability and testability.” Both are asserted as necessary to scientific status, and the converse of one (un-observability) is asserted to preclude the possibility of the other (testability).

It turns out, however, that both parts of this formula fail. First, many scientific theories invoke unobservable entities to explain observable data, as theoretical physics if nothing else has abundantly demonstrated. Forces, fields, atoms and quarks are all unobservable. The postulation of such entities is no less the product of scientific inquiry for that. Similarly, past events, mental states, subsurface geological features and many cellular and molecular structures are unobservable entities. All are, however, inferred from observable phenomena. Most are also unambiguously regarded as part of scientific inquiry.

Further, unobservability does not preclude testability: claims about unobservables are routinely tested in science *indirectly* against observable phenomena. That is, the existence of unobservable entities is established by testing the explanatory power that would result if a given hypothetical entity (i.e., an unobservable) were accepted as real or operative. This kind of testing usually involves some assessment of the established or theoretically plausible causal powers of a given unobservable entity. In any case, many scientific theories are evaluated indirectly by comparing their explanatory power against the explanatory power of competing hypotheses.

Consider an example. During the race to elucidate the structure of the genetic molecule, both a double helix and a triple helix were considered, since both could explain the photographic images produced via x-ray crystallography.¹²¹ While neither structure could be observed (even indirectly through a microscope), the double helix of Watson and Crick eventually won out because it could explain other observations that the triple helix could not. The inference to one unobservable structure—the double helix—was accepted because it was judged to possess a greater explanatory

121. H. Judson, *The Eighth Day of Creation* (New York: Simon and Schuster, 1979), pp. 157-90.

power than its competitors with respect to a variety of relevant observations. Such attempts to infer to the best explanation, where the explanation presupposes the reality of an unobservable entity, occur frequently in many fields already regarded as scientific, including physics, geology, geophysics, molecular biology, genetics, physical chemistry, cosmology, psychology and, of course, evolutionary biology.

As such, the unobservable character of the intelligence inferred by design theorists does not provide an in principle basis for disqualifying the theory of intelligent design from consideration as a scientific theory. If it did, neo-Darwinism (and all other evolutionary theories) would also fail to qualify as a scientific theory. Indeed, evolutionary theorists have long defended the allegedly unfalsifiable¹²² (and untestable) nature of their theoretical claims by reminding critics that many of the creative processes to which they refer occur at rates too slow or (in the case of Stephen J. Gould's theory of punctuated equilibrium) too fast to observe.

Further, the core historical commitment of evolutionary theory, that present species are related by common ancestry, has an epistemological standing that is very similar to that of the theory of intelligent design. The transitional life forms that ostensibly occupy the nodes on Darwin's branching tree of life are unobservable, just as the postulated past activity of a designing intelligence is unobservable.¹²³ Transitional life forms are theoretical postulations that make possible evolutionary explanations of present biological data. An unobservable designing agent is, similarly, postulated to explain observable features of the living world such the chemical sequences that store information in DNA, and the miniature machines and complex circuits found in cells. The theory of intelligent design does invoke an unobservable designing intelligence, but it does so to explain observable features of the living world. Moreover, design theorists test and justify their inferences to intelligent design by comparing the explanatory power of the design hypothesis against that of rival hypotheses. Indeed, I have self-consciously applied this method of testing in the papers that

122. The celebrated philosopher of science Karl Popper, applying his falsifiability criterion for scientific theories, concluded in 1976 that "Darwinism is not a testable scientific theory, but a metaphysical research programme." KARL POPPER, *UNENDED QUEST* (Glasgow: Fontana, Collins, 1976), p.151. Later he softened his judgment under pressure.

123. Stephen C. Meyer, "Of Clues and Causes: A Methodological Interpretation of Origin of Life Studies" (Ph.D. dissertation, Cambridge University, 1991), p. 120; DARWIN, *ORIGIN OF SPECIES*, p. 398; D. HULL, *DARWIN AND HIS CRITICS* (Chicago: University of Chicago Press, 1973), p. 45.

I have written making a case for intelligent design as the best explanation of the presence of the biological information in living systems.¹²⁴ In so doing, I have followed the standard methodological practice of the historical sciences.

Indeed, Darwin used this indirect method of testing and insisted that standards of direct verification or observation of hypotheses were wholly irrelevant to evaluating theories of origins. As he complained to Joseph Hooker: “I am actually weary of telling people that I do not pretend to adduce *direct* evidence of one species changing into another, but that I believe that this view in the main is correct because so many phenomena can be thus grouped and *explained*.”¹²⁵ Further, Darwin used precisely the same method of testing—inference to the best explanation—that I and other design theorists have used to evaluate and justify our proposals in our technical scientific work. In a letter to the American biologist Asa Gray he explained how he used this method of comparative hypothesis testing to assess his own theory of common descent:

I . . . test this hypothesis [common descent] *by comparison* with as many general and pretty well established propositions as I can find—in geographical distribution, geological history, affinities, etc. etc. And it seems to me that, supposing that such a hypothesis were to explain such general propositions, we ought, in accordance with the common way of following all sciences, to admit it until *some better hypothesis* be found out.¹²⁶

Pennock claims that the theory of intelligent design cannot be tested for a second, though related, reason. He claims the theory of intelligent design is not testable because it does not refer to “causal laws” (or law-like processes) that would allow it to be tested by isolating variables under controlled laboratory conditions. Indeed, he seems to uphold the testing of causal laws in a laboratory setting as *the* method of scientific testing. As he describes it: “we confirm causal laws by performing controlled experiments in which the hypothesized independent variable is made to vary while all other factors are held constant so that we can observe the effect on the dependent variable.” (p. 21) Further, he seems to suggest that because only causal laws or law-like processes can be tested by

124. S.C. Meyer, *The Origin of Biological Information and the Higher Taxonomic Categories*, PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON, 117(2) (2004): 213-239.; Stephen C. Meyer, *DNA and the Origin of Life: Information, Specification and Explanation*, in DARWINISM, DESIGN AND PUBLIC EDUCATION (Michigan State University Press, Meyer and Campbell, eds., 2003).

125. C. Darwin, *More Letters of Charles Darwin*, ed. F. Darwin, 2 vols. (London: Murray, 1903), 1:184 (emphasis added).

126. Francis Darwin, ed., *LIFE AND LETTERS OF CHARLES DARWIN*, 2 vols. (London: D. Appleton, 1896), 1:437. (emphasis added).

isolating variables, only theories that refer to such processes are scientific. Thus he assumes tacitly that (a) only hypotheses about causal laws can be tested scientifically, and further that (b) the *only* scientific method of testing hypotheses involves isolating variables under controlled and repeatable laboratory conditions.

Both these assumptions are false. As noted above, scientists not only formulate hypotheses about law-like regularities or causal laws, but they also formulate hypotheses about causal *events*, including events that may have occurred in the distant past. Theories in the historical sciences often posit such past events or “causal histories” to explain how some entity might have arisen or to explain why we observe certain data or artifacts today. Chemical evolutionary theory and Darwin’s theory of common descent are scientific theories that have precisely this kind of historical character.¹²⁷ Both posit a hypothetical series or pattern of past events to explain the origin of living forms and other data that we observe in the present.

Historical scientific explanations postulate events or sequences of events that occurred in the distant past, and which may not reoccur. Thus, historical scientific hypotheses are not tested in the manner Pennock envisions. Certainly, Darwin’s theory of universal common descent was not tested this way. As noted, Darwin used an indirect method of testing known as inference to the best explanation (sometimes called “the method of multiple competing hypotheses”) to test and justify his theory. His theory was not judged by its ability to predict outcomes once certain variables had been fixed. Rather it was tested by comparing its ability to explain a variety of *already known* biological phenomena (homology, fossil evidence, embryological similarity) against the explanatory power of its main competitors.

Methods of testing that depend upon direct verification or repeated observation of cause-effect relationships under controlled laboratory conditions have little relevance to historical theories generally, or to evolutionary theories in particular. When Pennock implies that to study something scientifically, scientists must perform “controlled experiments in which the hypothesized independent variable is made to vary while all other factors are held constant so that we can observe the effect on the dependent variable,” (p. 21) he sets a standard for science that neither Darwin’s

127. Stephen C. Meyer, “Of Clues and Causes,” pp. 77-136, 169-225.

theory of common descent nor any other historical scientific theory can usually meet. Thus, Pennock's characterization of scientific testing if applied consistently, would disqualify not only the theory of intelligent design from consideration as a scientific theory, but also key parts of neo-Darwinism and chemical evolutionary theory as well.

Nevertheless, it is not the case that causal laws play no role in historical scientific inquiry. Instead, our knowledge of causal laws or, at least, our knowledge cause and effect relationships, usually plays a subsidiary role in such historical scientific inquiry. Historical scientists usually use their knowledge of the present cause and effect structure of the world to judge the plausibility of various competing hypotheses about the past. (This is sometimes referred to as uniformitarian reasoning). Those hypotheses that posit causes that are known to have the power to produce an effect in question are judged to be superior to those hypotheses that lack such “causal powers.” Thus, Darwin used knowledge of the cause and effect structure of the world—in particular his understanding of the kind of effects that natural selection could produce if given enough time—to justify his historical theory of universal common descent (with its claim that a vast amount of continuous biological change had occurred in the past).

Interestingly, however, advocates of the theory of intelligent design also use such uniformitarian reasoning. That is, design theorists use knowledge of the cause and effect structure of the world to assess the plausibility of the competing explanations that have been offered for, say, the origin of biological information. In the process, they also refer to “causal laws,” or, at least, to our knowledge of cause and effect relationships. Dembski, for example, has proffered a law of information conservation. It claims, roughly, that large amounts of specified information (or “complex specified information,” as he puts it) do not arise from purely physical and chemical causes or antecedent conditions, but instead only from intelligent causes. Or, as I have argued, we know from experience that large amounts of new information invariably arise from intelligent sources. That is, whenever we observe information-rich systems and we know how such systems arose, invariably intelligence played a role. Or to quote Henry Quastler again: “information habitually arises from conscious activity.”¹²⁸ Since, as design theorists argue, intelligence is the only

128. HENRY QUASTLER, *THE EMERGENCE OF BIOLOGICAL ORGANIZATION* (1964), at 16.

known entity with the causal powers to produce large amounts of functionally specified information, the presence of such information in living systems points strongly to a prior designing intelligence. (We dispute the studies that Kenneth Miller cites in his Report that claim to explain how large amounts of biological information can arise without assistance from a guiding—or programming—intelligence¹²⁹). Thus, contrary to Pennock's analysis, the theory of intelligent design can be evaluated and tested. Moreover, it can be tested in exactly the same way as other historical scientific theories, namely, by evaluating the relative causal and explanatory efficacy of the design hypothesis against its competitors (and against our knowledge of the cause and effect structure of the world).

Even so, historical scientific hypotheses are not typically about causal laws (as Pennock implies); instead they posit past causal events. Our knowledge of the cause and effect structure of the world merely enables us to judge and evaluate those hypotheses. Thus, causal laws are not the main or sole focus of historical scientific inquiry. And since laws aren't the focus of historical scientific theories, they are not the main, or sole, focus of testing such theories either. And for that reason, many important aspects of historical scientific theories—in particular their claims about past events and causes—cannot be tested under controlled laboratory conditions of the kind that Pennock takes to be necessary to scientific practice and status.

Finally, Pennock claims that the theory of intelligent design is untestable because it invokes a supernatural being with unlimited (omnipotent) powers. Since such a being has powers that could be invoked to “explain any result in any situation,” all events are consistent with the actions of such a being, and therefore, no conceivable event could disprove the hypothesis of supernatural or divine action. Pennock's misrepresentation of the theory of intelligent design renders this objection irrelevant. Because a supernatural being with unlimited causal powers could cause any event whatsoever to occur, such a being always remains a possible explanation for any event. But the theory of intelligent design does not claim to detect a supernatural possessing unlimited powers. Nor does it formulate a hypothesis that is consistent with any event or situation whatsoever. Instead, it claims to detect the action of a prior *intelligent* cause. It does so, design theorists argue, based upon

129. Schneider, T.D., *Evolution of Biological Information* NUCLEIC ACIDS RESEARCH, vol. 28: 2794-2799 (2000); Lenski, R. E., et al., *The Evolutionary Origin of Complex Features*, NATURE 423:139-144 (2003).

evidence that points unambiguously to an intelligent cause rather than undirected natural processes. Thus, the theory of intelligent design does merely affirm that intelligence constitutes a *possible* explanation of certain features of living systems—such as their high information content or irreducible complexity—it argues that intelligent design constitutes the *best* explanation of these features, based upon what we know about the cause and effect structure of the world. It follows, therefore, that if the cause and effect structure of the world were different from what design theorists claim—for example, if “complex specified information did arise from purely chemical and physical antecedents,” then the contemporary design hypothesis, with its strong claim to be the best (clearly superior) explanation of such phenomena, would be refuted. Similarly, if key *indicia* of intelligence—such as digital information or irreducibly complex systems—were not present in living systems, the design hypothesis would not stand as the best explanation of living systems and would, in its present strong form at least, be refuted. Thus, Pennock incorrectly portrays the theory of intelligent design as a theory that is insulated from evidentiary refutation. In short, the theory of intelligent design is testable.

4. *Further Problems with the Principle of Methodological Naturalism*

As we have seen, Pennock claims that excluding consideration of the theory of intelligent design is entirely reasonable given the methodological characteristics of science. In other words, he affirms an extra-evidential principle known as “methodological naturalism.”¹³⁰ Methodological naturalism asserts that, as a matter of definition, for a hypothesis, theory, or explanation to qualify as “scientific,” it must invoke only naturalistic or materialistic entities. On that definition, critics say, the intelligent design hypothesis does not qualify as a scientific theory.

As the preceding sections demonstrate, however, methodological naturalism now lacks justification as a normative definition of science. Attempts to justify methodological naturalism—i.e., the a priori exclusion of intelligent design from consideration as a scientific

130. M. Ruse, “*McLean v. Arkansas*: Witness Testimony Sheet,” in M. Ruse, ed., *But Is It Science?* (Amherst, N.Y.: Prometheus Books, 1988), p. 103; Stephen C. Meyer, “The Scientific Status of Intelligent Design: The Methodological Equivalence of Naturalistic and Non-naturalistic Origins Theories,” in *Science and Evidence for Design in the Universe*, ed. Behe, Dembski, Meyer (Ignatius Press, 2000), pp. 151-211.

theory— by reference to various demarcation criteria have failed.¹³¹

There are other problems with asserting methodological naturalism as a normative definition of science.

First, not all scientists have accepted the principle. Newton, for example, made design arguments within his scientific works, most notably in the *Principia* and in the *Opticks*.^{131a} Louis Aggasiz, a distinguished paleontologist and contemporary of Darwin, also made design arguments within his scientific works. Thus, current defenders of the principle can at best claim that the principle of methodological naturalisms has had normative force only during certain periods of scientific history. But that suggests that methodological norms can change. And, indeed, part of the current debate about the theory of intelligent design is precisely about whether the principle of methodological naturalism should be regarded as normative today. Darwinists say it should remain normative; design theorists dispute this. Thus, critics of intelligent design can't settle the debate about whether the theory of intelligent design should be permitted as a scientific hypotheses by invoking the principle of methodological naturalism because the principle is itself a large part of what the controversy is about.

Second, treating methodological naturalism as a normative principle for all of science has an intellectually stifling effect on the practice of certain scientific disciplines, especially the historical sciences. In historical biology or origin-of-life research, for example, methodological naturalism artificially restricts inquiry and prevents scientists from seeking some hypotheses that might provide the most likely, best, or causally adequate, explanations. To be a truth-seeking endeavor, the question that historical or evolutionary biology must address is not "Which materialistic scenario seems most adequate?" but rather "What actually caused life to arise on earth and to develop into new forms of life?" Clearly, one possible answer to this question is: "Life was designed by an intelligent agent that existed before the advent of humans." If one accepts methodological naturalism as normative, however, scientists may never consider the design hypothesis as possibly true. Such an exclusionary

131. Meyer, "Scientific Status"; L. Laudan, "The Demise of the Demarcation Problem," in M. Ruse, ed., *But Is It Science?* pp. 337-50; L. Laudan, "Science at the Bar—Causes for Concern," in Ruse, *ibid.*, pp. 351-55; A. Plantinga, "Methodological Naturalism?" *Origins and Design* 18 (1) (1986): 18-26; A. Plantinga, "Methodological Naturalism?" *Origins and Design* 18 (2) (1986): 22-34.

131a. See footnote 73.

logic diminishes the significance of any claim of theoretical superiority for any remaining hypothesis and raises the possibility that the best “scientific” explanation (as defined by methodological naturalism) may not be the best in fact.

As many historians and philosophers of science now recognize, scientific theory-evaluation is an inherently comparative enterprise. Theories that gain acceptance in artificially constrained competitions can claim to be neither “most probably true” nor “most empirically adequate.” At best such theories can be considered the “most probably true or adequate among an artificially limited set of options.” Openness to the design hypothesis would seem necessary, therefore, to any fully rational historical biology—i.e., to one that seeks the truth, “no holds barred.”¹³² Conversely, treating methodological naturalism as normative could impede scientific investigation about what actually happened to cause life to arise on earth.

C. Teaching about the Theory of Intelligent Design Does Not Constitute an Establishment of Religion

In addition to asserting that the theory of intelligent design does not qualify as science, Pennock claims that the theory of intelligent design is “religion.” Rather than present a clear statement of how one determines whether a belief is or is not religious in nature, Pennock offers a series of quotations that he believes support his assertion. There are three problems with his approach.

1. *Pennock Provides No Criterion to Determine What Constitutes Religion*

First, Pennock fails to specify criteria for classifying a theory or idea as “religion.” Yet absent such criteria, Pennock cannot substantiate his claim that the theory of intelligent design is religion, still less “religion” in any constitutionally-relevant sense. Moreover, as my law professor co-authors and I have argued elsewhere,¹³³ the constitutionally relevant definition of religion, namely that of the *Lemon* test, does not support Pennock’s claim that the theory of intelligent design is religion, much less that teaching about the theory of intelligent design constitutes an establishment of religion.

132. P. Bridgman, *Reflections of a Physicist*, 2nd ed. (New York: Philosophical Library, 1955), p. 535.

133. DeWolf, Meyer & DeForrest, *Teaching the Origins Controversy: Science, Or Religion, or Speech?* 2000 UTAH LAW REVIEW 39

2. *Metaphysical Implications Are Not Unique to the Theory of Intelligent Design*

Pennock incorrectly assumes that if a theory has significant metaphysical or religious implications, it cannot be a scientific theory and must be categorized as religion. But there is no reason to assume this. For example, many scientists believe that the Big Bang theory, with its affirmation that the universe had a temporal beginning, has positive implications for a theistic worldview. These possible implications did not prevent scientists from first considering, and then accepting, the Big Bang theory as a plausible scientific explanation for the origin of the universe. Nor have they led anyone to regard the Big Bang as a religion.

To cite another example, archaeology often yields data or artifacts that may prove supportive or subversive of particular religious traditions. Yet those implications do not make archaeology a religion, or any less of a science.

More pointedly, some scientists think that Darwinism, and other materialistic origins theories, have significant metaphysical and religious (or anti-religious) implications. Indeed, a host of prominent Darwinian scientists—from Douglas Futuyma¹³⁴ to William Provine¹³⁵ to Stephen Jay Gould¹³⁶ to Richard Dawkins—have insisted that Darwinism has made traditional beliefs about God and humanity either untenable or less plausible. Dawkins, for example, has stated, “Darwin made it possible to become an intellectually fulfilled atheist.”¹³⁷ Or consider the following statements by Gould:

- [B]iology took away our status as paragons created in the image of God. . . .¹³⁸
- Before Darwin, we thought that a benevolent God had created us.¹³⁹
- [W]hy do humans exist? . . . I do not think that any “higher” answer can be given We are the offspring of history, and must establish our own paths in this most diverse and interesting of conceivable universes—one indifferent to our suffering, and therefore offering

134. See DOUGLAS J. FUTUYMA, *EVOLUTIONARY BIOLOGY* 5 (3d ed. 1998).

135. See William Provine, *Evolution and the Foundation of Ethics*, 3 MBL SCIENCE 25, 26 (1988) (“The implications of modern evolutionary biology are inescapable [E]volutionary biology undermines the fundamental assumptions underlying ethical systems in almost all cultures, Western civilization in particular.”).

136. See STEPHEN JAY GOULD, *EVER SINCE DARWIN* 147 (1977).

137. RICHARD DAWKINS, *THE BLIND WATCHMAKER* (1986), p. 6.

138. *Id.*

139. *Id.* at 267.

us maximal freedom to thrive, or to fail, in our own chosen way.¹⁴⁰

Contrary to the popular *just-the-facts* stereotype of science, many scientific theories have larger ideological and religious implications.¹⁴¹ Origins theories, in particular, raise unavoidable philosophical and religious considerations. Theories about where the universe, life, and humanity came from invariably affect our perspectives about human nature, morality, and ultimate reality. As the preceding quotations have made clear, Darwinism has implications for such questions.

Darwinism (in both its classical and contemporary versions) insists that living systems arose without the assistance of a guiding intelligence.¹⁴² Chemical evolutionary theorists likewise insist that the first life arose, without direction, from brute chemistry.¹⁴³ The Oxford zoologist Richard Dawkins has dubbed the idea that life arose as the result of an undirected process as the “blind watchmaker” thesis.¹⁴⁴ He and other leading evolutionary theorists claim that biological evidence overwhelmingly supports this purposeless and fully materialistic account of creation.¹⁴⁵ Thus George Gaylord Simpson, the leading neo-Darwinist a generation ago, could claim: “Man is the result of a *purposeless* and materialistic process that did not have him in mind. He was not planned.”¹⁴⁶

Accordingly, many major biology texts present evolution as a process in which a purposeful intelligence (such as God) plays no detectable role. As Miller and Levine explained in a previous edition¹⁴⁷ of their popular textbook, the evolutionary process is “random and undirected” and occurs “without plan or purpose.”¹⁴⁸ Or as Purvis, Orians and Heller tell students, “The living world is constantly evolving without any goals. Evolutionary change is not directed.”¹⁴⁹ Some texts even

140. STEPHEN JAY GOULD, *WONDERFUL LIFE* 323 (1989).

141. One example is the debate over the most effective polio vaccine—the one developed by Jonas Salk or the one developed by Albert Sabin. The debate over superiority was not only about science, but involved controversies over the rights of individual patients versus public health and the proper role of doctors in public policy debates. DeWolf, Meyer & DeForrest, *Teaching the Origins Controversy: Science, Or Religion, or Speech?* 2000 UTAH LAW REVIEW 2000:88, note 251. Other examples could be easily multiplied, such as the issues of global warming, the effect of electromagnetic radiation on health, and the risks associated with cellular telephones or breast implants.

142. See Francisco Ayala, “Darwin’s Revolution,” in *Creative Evolution?!*, eds. J. Campbell and J. Schopf (Boston, Mass.: Jones and Bartlett Publishers, 1994), pp. 4-5.

143. See KENYON & STEINMAN, *BIOCHEMICAL PREDESTINATION* (1969), at 6.

144. See RICHARD DAWKINS, *THE BLIND WATCHMAKER* 5 (1996).

145. See *id.* at 1-6.

146. GEORGE GAYLORD SIMPSON, *THE MEANING OF EVOLUTION* 344 (rev. ed. 1967) (emphasis added).

147. A later edition of the textbook deleted this language.

148. KENNETH R. MILLER & JOSEPH LEVINE, *BIOLOGY* 658 (4th ed. 1998).

149. W. K. PURVIS, G.H. ORIAN, AND H.C. HELLER, *LIFE: THE SCIENCE OF BIOLOGY*, (4th ed., Sunderland, Mass: Sinauer Associates, 1995), p. 14

state that Darwin's theory has profoundly negative implications for theism, and especially for its belief in the purposeful design of nature. As Douglas Futuyma's biology text explains: "By coupling undirected, purposeless variation to the blind, uncaring process of natural selection, Darwin made theological or spiritual explanations of the life processes superfluous."¹⁵⁰ Conversely, some scientists, such as Kenneth Miller, believe that evolutionary theory reinforces their religious beliefs.¹⁵¹ Either way, Darwinian evolutionary theory (like the theory of intelligent design) raises unavoidable metaphysical and religious questions.

3. *Theistic Implications No More Make Intelligent Design a Religion than the Religious (or Anti-religious) Implications of Neo-Darwinism*

Clearly, many scientists think that evolutionary theory has larger metaphysical, religious (or anti-religious) or worldview implications. This fact has not prevented Darwinism from being regarded as a scientific theory. Indeed, the content of a scientific theory, and not its implications, determine its scientific merit.

For this reason, the possible theistic implications of intelligent design should not disqualify it from consideration as a scientific theory, any more than the possible implications of Darwinian evolutionary theory should disqualify it from similar consideration. As I have explained elsewhere, in particular to the U.S. Commission on Civil Rights, Darwinism and the theory of intelligent design are equivalent in this respect. Both theories draw inferences from biological evidence; both theories arguably have larger metaphysical, religious (or anti-religious) or worldview implications. If design theory is religious, then so is Darwinism. If Darwinism is science, then so is the theory of intelligent design.

According to the theory of intelligent design, an unspecified designing intelligence is responsible for the "irreducibly complex"¹⁵² and "information-rich" structures in biological organisms.¹⁵³ Students who believe in God may identify the designing intelligence allegedly

150. DOUGLAS J. FUTUYMA, *EVOLUTIONARY BIOLOGY* 5 (3d ed. 1997).

151. KENNETH MILLER, *FINDING DARWIN'S GOD* (1999), p. 291: "In many respects, evolution is the key to understanding our relationship with God."

152. See BEHE, *DARWIN'S BLACK BOX*, at 203.

153. See Meyer, *DNA By Design: An Inference to the Best Explanation for the Origin of Biological Information*, 1 *RHETORIC AND PUBLIC AFFAIRS* 519 (1998).

responsible for biological complexity with the God of their religious belief. In so doing, they may find support for their faith. Alternatively, students with no religious convictions may find that scientific arguments for design lead them to ask theological questions and to inquire into the identity of such a designing intelligence.

This potential for metaphysical extrapolation, however, is not unique to design theory. Darwinism, and other materialistic origins theories, afford a similar potential. Indeed, non-religious students may find support for agnostic or materialistic metaphysical beliefs in Darwinian theory. Similarly, a religious student might find a materialistic worldview more plausible as a result of a scientific study of Darwinism. Or if Ken Miller is correct, the study of evolutionary theory may lead a student to “find Darwin’s God.”

Of course, some might argue that scientists do not discuss the implications of evolutionary theory in their technical scientific writing, but instead confine their discussion of such topics to popular books, textbooks, scientific essays, interviews, and newspaper articles. Michael Ruse, in particular, has distinguished scientific evolutionary writing from popular evolutionary writing, and insists that evolutionary theorists only discuss the anti-religious (or religious) implications of neo-Darwinism in their popular publications.¹⁵⁴ Interestingly, in this context he acknowledges that neo-Darwinism functions for many scientists as a kind of “secular religion.”¹⁵⁵ Even so, Ruse maintains that the use of Darwinian theory to support religious (or anti-religious) argument does not disqualify technical evolutionary writing of scientific status.

This same distinction applies to the work of intelligent design theorists, and should apply to the evaluation of the scientific status of their technical publications. Like Darwinists, advocates of intelligent design do discuss the potential theological implications of their theory in popular books, articles, speeches, newspaper interviews, and philosophical journals. In their technical scientific works, however, design theorists do not speculate regarding the nature or identity of the intelligence responsible for the complexity of life. Instead, they use rigorous methods of design detection and comparative hypothesis testing to make inferences to an intelligent cause as the best explanation for

154. Michael Ruse, *Is Evolution a Secular Religion?* 299 *SCIENCE* 1523 (March 2003).

155. *Id.*: “I am saying that this popular evolutionism—often an alternative to religion—exists.”

the biological data they observe. In this context they carefully avoid speculating about the nature and identity of the intelligent cause that they infer. Moreover, we do so, not to conceal a hidden religious agenda, but instead to be careful not to claim more than the scientific data alone will justify. As several design theorists have noted, to address the issue of the identity or nature of the designer requires second-order philosophical deliberation; the biological evidence alone cannot adjudicate this question.¹⁵⁶ In any case, that design theorists discuss the implications of their theory in popular publications or philosophical journals should not disqualify their technical writing from consideration as science, any more than the popular writing of leading evolutionary theorists should disqualify their technical writing from similar consideration.

Nevertheless, Pennock repeatedly cites the popular writings and speeches of advocates of intelligent design as if they represented the technical scientific case for the theory and the theory itself.¹⁵⁷ Indeed, he treats expression of personal opinion and philosophical deliberation as equivalent to the theory of intelligent design itself. He also consistently misrepresents the propositional content of the theory of intelligent design by claiming falsely that intelligent design posits a supernatural explanation; that design is “inherently supernatural” (Report, p. 3); or that it seeks to “confirm supernatural hypotheses.” Yet strangely, at one point he acknowledges that advocates of the theory of intelligent design deny that their methods can determine whether the intelligence responsible for biological complexity is natural or supernatural. On page 12 he quotes Kenyon and Davis, “Archaeology has pioneered the development of methods for distinguishing natural and intelligent causes. We should recognize, however, that if we go further and conclude that the intelligence responsible for biological origins is outside the universe (supernatural), or within it, we do so without the help of science.” Indeed, design theorists have repeatedly emphasized that their methods of design detection permit inferences to *intelligent* causes, but do not allow scientists to

156. Stephen C. Meyer, *Return of the God Hypothesis*, 11 JOURNAL OF INTERDISCIPLINARY STUDIES 1-38 (1999); WILLIAM DEMBSKI, THE DESIGN REVOLUTION, p. 42.

157. In particular, Pennock explicitly relies upon law professor Phillip Johnson in this regard as though his work were representative of the *scientific* merits of the theory of intelligent design. This is a puzzling choice. While Johnson has written extensively on the philosophical and cultural implications of design, he has never published technical scientific work developing a case for the theory.

determine whether the intelligence in question is *natural* or *supernatural*.¹⁵⁸ Pennock badly misrepresents the claims of the theory of intelligent design on this score.

In any case, the courts have recognized that if the implications of neo-Darwinism (as articulated by some of its chief advocates) were equivalent to the theory itself, neo-Darwinism would be vulnerable to exclusion from the public school curriculum. As Justice Hugo Black once asked, “[I]f the theory [of evolution] is considered anti-religious, as the Court indicates, how can the State be bound by the Federal Constitution to permit its teachers to advocate such an ‘anti-religious’ doctrine to schoolchildren?”¹⁵⁹ Of course, Justice Black’s question was purely hypothetical, since he did not advocate actually forbidding teachers to teach about Darwinian evolutionary theory.¹⁶⁰ Indeed, such an outcome would be unthinkable. Yet, if the religious (or anti-religious) implications, rather than the specific propositional content, of theories were at issue, then arguably neither Darwinian theory nor design theory could pass constitutional muster. But obviously Darwinian theory *has* passed constitutional muster, precisely because the courts have recognized the distinction between a scientific theory and its metaphysical, religious (or anti-religious) implications.

4. *The Theory of Intelligent Design Does Not Affirm Narrow Sectarian Doctrines*

Pennock claims that the theory of intelligent design not only affirms a “theistic view,” but narrowly sectarian doctrines. Yet upon closer examination this claim evaporates into nothing more than the observation that theory of intelligent design is popular with many evangelical Christians, and that many design theorists reject theistic evolution, while many Catholics and liberal Protestants happen to accept it.¹⁶¹ In any case, the theory of intelligent design with its—at best—broadly theistic implications, does not affirm any narrow sectarian doctrines.¹⁶² It has nothing to say to say about,

158. “Intelligent design is modest in what it attributes to the designing intelligence responsible for the specified complexity in nature. For instance, design theorists recognize that the nature, moral character and purposes of this intelligence lie beyond the competence of science and must be left to religion and philosophy.” WILLIAM DEMBSKI, *THE DESIGN REVOLUTION*, p. 42.

159. *Epperson v. Arkansas*, 393 U.S. 97, 113 (1968) (Black, J., concurring).

160. *See id.* at 109-14 (Black, J., concurring).

161. Pennock does not explain the fact that many prominent advocates of the theory of intelligent design happen to be Catholic, including Dean Kenyon, Michael Behe, and Ben Wiker).

162. Even if it were true that design advocates cite it in support of specifically sectarian opinions, the same accusation can be laid at the doorstep of leading advocates of neo-Darwinism. For example, Eugenie Scott, the Executive Director of the National Center for Science Education, suggested that biology teachers invite their students to survey community religious leaders to find out which ones accept evolution. She notes that the “survey-of-

for example, the Virgin Birth, the immaculate conception, predestination, infant baptism, Islamic law or Reincarnation. Moreover, the belief that a designing intelligence played a role in the origin of the living world is hardly unique to evangelical Christians, or to religious persons in general. Advocates of design have included not only religious theists, but non-religious ones, pantheists, polytheistic Greek, Roman stoic, and deistic Enlightenment philosophers, and now include modern scientists and philosophers who describe themselves as religiously agnostic.¹⁶³

5. *Religious Motivations of Scientists Do Not Disqualify the Scientific Theories They Advocate*

Throughout her nearly fifty-page Report, Professor Barbara Forrest attempts to document the religious beliefs and putative motives of some of the scientists and scholars who support the theory of intelligent design. To do so she analyzes with a seemingly obsessive zeal a single fundraising document authored in 1998 by a then-junior staff member of the Center for the Renewal of Science and Culture. Yet, as the director of the Center for Science and Culture, the organization about which Dr. Forrest purports expertise, I can verify that she has never communicated with me in any way about the wedge document or any other matter. Her expertise about the putative plans, purposes and strategies of the organization that I direct should be regarded with skepticism. Further, I can verify that her testimony in her Report about my thinking and my intellectual biography is misleadingly incomplete and extremely inaccurate—and certainly this is a topic about which my expertise exceeds her own!

Notwithstanding, there is no question that many advocates of the theory of intelligent design do have religious interests and theistic beliefs and that some are motivated by their beliefs. For Forrest and Pennock evidence of this fact de-legitimizes the theory of intelligent design. But this doesn't follow for several reasons.

ministers approach may not work if the community is religiously homogeneous, especially if that homogeneity is conservative Christian . . .” Eugenie C. Scott, *Dealing with Anti-evolutionism*, REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION
<http://www.ncseweb.org/resources/articles/6172_dealing_with_antievolutionism_1_9_2001.asp>.

163. Michael Denton, whose book *EVOLUTION: A THEORY IN CRISIS* (1985) identified major theoretical problems for modern neo-Darwinism, is an agnostic. Anthony Flew, a long-time champion of atheism, recently announced his abandonment of atheism based on the evidence of intelligent design, but emphasized that his religion was far from conventional (much less sectarian): “I’m thinking of a God very different from the God of the Christian and far and away from the God of Islam, because both are depicted as omnipotent Oriental despots, cosmic Saddam Husseins,” See, “Famous Atheist Now Believes in God,” <http://abcnews.go.com/US/wireStory?id=315976>

First, it's not what motivates a scientist's theory that determines its merit, status or standing; it's the quality of the arguments and the relevance of the evidence marshaled in support of a theory. Even, if all the scientists who have advocated the theory of intelligent design were motivated by religious belief (and they are not), motives don't matter to science. Evidence does. To say otherwise commits an elementary logical fallacy known as the *ad hominem*.

Second, scientists on both sides of the controversy (over Darwinism and intelligent design) have religious motivations. Forrest herself is a Board Member of the New Orleans Secular Humanist Association, which advances a religious (or anti-religious) agenda. Other prominent Darwinists, including Eugenie Scott and Michael Shermer, have signed the American Humanist Manifesto III. Recall also that the noted Darwinist Richard Dawkins has praised Darwin's theory because it "made it possible to be an intellectually fulfilled atheist."¹⁶⁴ Kenneth Miller takes a different, though no less religiously disinterested tack, by claiming that Darwinism illuminates his religious beliefs.¹⁶⁵ Either way, design theorists aren't the only scientists with religious beliefs, predilections or motives.

Does this evidence of religious and/or anti-religious motive among leading advocates of evolutionary disqualify Darwinian evolution from consideration as a scientific theory or diminish the merit of the theory? Obviously, it does not. The religious (or anti-religious) motivations of the proponents of a theory don't negate the scientific status, merit or validity of that theory. But if that is the case generally, and the case for neo-Darwinism, then clearly the same principle should apply when considering the scientific status and merits of the theory of intelligent design.

Similarly, the Court has ruled that the religious motivations of those who advocate a particular public policy do not make the adoption of such a policy unconstitutional, provided the state action in question serves a valid secular purpose. Thus, as my law professor colleagues and I have shown, even if teachers or school boards have religious motives for wanting to allow teachers to teach students about the theory of intelligent design, advocacy for such a policy would not necessary constitute an establishment of religion under the first prong of the *Lemon* test. Indeed, the *Lemon* test does not require that advocates of a government action have *no* religious motivations,

164. RICHARD DAWKINS, *THE BLIND WATCHMAKER*, p. 6.

165. KENNETH MILLER, *FINDING DARWIN'S GOD* (1999).

only that a government action or policy advances a secular purpose.¹⁶⁶

And, it happens, that teachers or school boards may well have many valid secular purposes for teaching students about the theory of intelligent design. For example, a teacher or school board may want to improve science education by exposing students to the full range of views that exist among scientists about biological origins.¹⁶⁷ A teacher or school board may want to teach about the controversy between Professor Michael Behe and Professor Ken Miller about the origin of “irreducibly complex” molecular machines to enhance students’ critical thinking skills or to interest them in the fascinating world of cell biology. A teacher or school board may want to teach about the theory of intelligent design to enhance student understanding of Darwinian argument based on the pedagogical theory that it is difficult to understand Darwinian argument without understanding its dialectical opposite. Or a teacher or school board may want to tell students about the theory of intelligent design alongside other theories (such as neo-Darwinism, self-organization, and punctuated equilibrium) as a way of illustrating the method of multiple competing hypotheses as it functions in the historical sciences. Teaching about the theory of intelligent design could conceivably embody many secular purposes. Thus, even if a teacher or school board has religious (or anti-religious) beliefs that affect their interest in the merits of the issue, if their curriculum embodies a secular purpose, it satisfies the *Lemon* test.¹⁶⁸

IV. Conclusion

Since the theory of intelligent design is no more inherently religious, and no less inherently scientific, than neo-Darwinism, the decision about whether to teach about it in the public schools is not a constitutional matter, but instead a matter of prudential and pedagogical judgment. Therefore, decisions about whether or not students should be taught about the theory of intelligent design should be left to local school boards and teachers.

The demise of demarcation arguments within the philosophy of science has made it difficult

166. See *Lemon*, 403 U.S. at 612.

167. As noted earlier, this was the purpose of the “Santorum language” incorporated into the Conference Report accompanying the No Child Left Behind Act.

168. See *Lemon*, 403 U.S. at 612.

for critics of design to label it unscientific in principle. As Laudan and others have argued, the status and merit of competing origins theories must be decided on the basis of empirical evidence and argument, not upon abstract philosophical or methodological litmus tests.¹⁶⁹ Yet as we have seen, design theorists make extensive appeals to such empirical evidence and argument. If there is no basis for classifying the theory of intelligent design as unscientific, or as a religious doctrine for establishment clause purposes, then there is no reason to forbid discussion of the theory of intelligent design within the public school science curriculum.

As a last-ditch argument, some have claimed that design theory is too new to merit discussion in biology classrooms.¹⁷⁰ Nevertheless, the relative novelty of design theory does not *justify* its exclusion on either legal or pedagogical grounds. The law provides no guidelines for determining how long a scientific theory must have existed in order to warrant teaching students about it. Further, good teachers know that exposing students to new (and even controversial) ideas can stimulate student interest and engagement and lead to greater subject mastery. Nor does science itself have a governing body that issues binding rulings about such matters. Instead, this constitutes a matter for local teachers and school boards to decide, based on their evaluation of the pedagogical value of the curriculum proposed.

Other critics of design have asserted another reason for exclusion: its minority status within the scientific community.¹⁷¹ Until design theory wins the support of the majority of scientists, they argue, students should not be exposed to the evidence or arguments for it.¹⁷² Yet such a view seems profoundly at odds with scientific practice, which itself involves dialogue and debate between scientists, some of whom advocate, from time to time, for new interpretations against established views. Those who insist that teachers may present only the majority view on a scientific issue, or that only majority opinions constitute “the scientific perspective,” overlook the history of science. Many established scientific theories originally met opposition from the majority of scientists. And science often involves argument between competing theoretical perspectives. As the Supreme Court stated

169. See Laudan, *Science*, at 351-55.

170. See *Hearings of the U.S. Commission on Civil Rights*, August 21, 1998, <http://www.discovery.org/scripts/viewDB/index.php?command=view&id=92>.

171. See *id.*

172. See *id.*

in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,¹⁷³ “Scientific conclusions are subject to perpetual revision. . . . The scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses, for those that are incorrect will eventually be shown to be so, and that in itself is an advance.”¹⁷⁴ Since no ruling body in science can determine when a minority scientific interpretation has attracted sufficient support to warrant discussion in the science classroom, the pedagogical debate will necessarily, and properly, devolve to individual teachers and local school boards.

V. Additional Information Regarding Testimony

1. Compensation

The compensation I will receive for my study, case preparation, and testimony in this matter is \$100.00 per hour. All travel expenses will be billed at cost.

2. Previous Testimony

I have not testified as an expert at trial or by deposition within the preceding four years.

3. Curriculum Vitae

My curriculum vitae is attached as Appendix B

Respectfully submitted.

Dated _____

Stephen C. Meyer, Ph.D.

173. 509 U.S. 579 (1993).

174. *Id.* at 579.

Appendix A: Publications Supporting the Theory of Intelligent Design

Peer-Reviewed Books Supportive of Intelligent Design Published by Trade Presses or University Presses

W.A. Dembski, *The Design Inference: Eliminating Chance through Small Probabilities* (Cambridge: Cambridge University Press, 1998).

This book was published by Cambridge University Press and peer-reviewed as part of a distinguished monograph series, *Cambridge Studies in Probability, Induction, and Decision Theory*. The editorial board of that series includes members of the National Academy of Sciences as well as one Nobel laureate, John Harsanyi, who shared the prize in 1994 with John Nash, the protagonist in the film *A Beautiful Mind*. Commenting on the ideas in *The Design Inference*, well-known physicist and science writer Paul Davies remarks: “Dembski’s attempt to quantify design, or provide mathematical criteria for design, is extremely useful. I’m concerned that the suspicion of a hidden agenda is going to prevent that sort of work from receiving the recognition it deserves.” Quoted in L. Witham, *By Design* (San Francisco: Encounter Books, 2003), p. 149.

Michael Behe, *Darwin’s Black Box: The Biochemical Challenge to Evolution* (The Free Press, 1996).

In this book Behe develops a critique of the mechanism of natural selection and a positive case for the theory of intelligent design based upon the presence of “irreducibly complex molecular machines” and circuits inside cells. Though this book was published by The Free Press, a trade press, the publisher subjected the book to standard scientific peer-review by several prominent biochemists and biological scientists.

Charles B. Thaxton, Walter L. Bradley, Roger L. Olsen, *The Mystery of Life’s Origin: Reassessing Current Theories* (Philosophical Library, 1984, Lewis & Stanley, 4th ed., 1992).

In this book Thaxton, Bradley and Olsen develop a seminal critique of origin of life studies and develop a case for the theory of intelligent design based upon the information content and “low-configurational entropy” of living systems.

John Angus Campbell and Stephen C. Meyer, *Darwinism, Design, & Public Education* (Michigan State University Press, 2003)

This is a collection of interdisciplinary essays that addresses the scientific and educational controversy concerning the theory of intelligent design. Accordingly, it was peer-reviewed by a philosopher of science, a rhetorician of science, and a professor in the biological sciences from an Ivy League university. The book contains five scientific articles advancing the case for the theory of intelligent design, the contents of which are summarized below.

Books Supportive of Intelligent Design Published by Prominent Trade Presses

Guillermo Gonzalez and Jay W. Richards, *The Privileged Planet: How Our Place in the Cosmos is Designed for Discovery* (Regnery Publishing, 2004).

Gonzalez and Richards develop a novel case for the theory of intelligent design based on developments in astronomy and planetary science. They show that the conditions necessary

to produce a habitable planet are extremely rare and improbable. In addition, they show that the one planet we are aware of that possesses these characteristics is also a planet that has characteristics uniquely adapted to scientific exploration, thus suggesting not simply that the earth is the recipient of the fortunate conditions necessary for life, but that it appears to be uniquely designed for scientific discovery.

William Dembski, *No Free Lunch: Why Specified Complexity Cannot be Purchased without Intelligence* (Rowman & Littlefield Publishers, 2002).

Dembski refines his scientific method of design detection, responds to critics of his previous book (*The Design Inference*) and shows how his method of design detection applies to the kind of molecular machines analyzed by Michael Behe in *Darwin's Black Box*.

Michael Denton, *Evolution: A Theory in Crisis* (Adler & Adler, 1985).

Denton, an Australian molecular biologist, provides a comprehensive critique of neo-Darwinian evolutionary theory. In a penultimate chapter, entitled "The Molecular Labyrinth," he also develops a strong positive case for the design hypothesis based on the integrated complexity of molecular biological systems. As a religiously agnostic scientist, Denton emphasizes that this case for design is based upon scientific evidence and the application of standard forms of scientific reasoning. As Denton explains, while the case for design may have religious implications, "it does not depend upon religious premises."

Articles Supportive of Intelligent Design Published in Peer-Reviewed Scientific Journals

Jonathan Wells, "Do Centrioles Generate a Polar Ejection Force? *Rivista di Biologia/Biology Forum* 98 (2005): 37-62.

Most animal cells contain a pair of centrioles, tiny turbine-like organelles oriented at right angles to each other that replicate at every cell division. Yet the function and behavior of centrioles remain mysterious. Since all centrioles appear to be equally complex, there are no plausible evolutionary intermediates with which to construct phylogenies; and since centrioles contain no DNA, they have attracted relatively little attention from neo-Darwinian biologists who think that DNA is the secret of life. From an intelligent design (ID) perspective, centrioles may have no evolutionary intermediates because they are irreducibly complex. And they may need no DNA because they carry another form of biological information that is independent of the genetic mutations relied upon by neo-Darwinists. In this paper, Wells assumes that centrioles are designed to function as the tiny turbines they appear to be, rather than being accidental by-products of Darwinian evolution. He then formulates a testable hypothesis about centriole function and behavior that—if corroborated by experiment—could have important implications for our understanding of cell division and cancer. Wells thus makes a case for ID by showing its *strong heuristic* value in biology. That is, he uses the theory of intelligent design to make new discoveries in biology.

S.C. Meyer, "The Origin of Biological Information and the Higher Taxonomic Categories," *Proceedings of the Biological Society of Washington*, 117(2) (2004): 213-239.

This article argues for intelligent design as an explanation for the origin of the Cambrian fauna. Not surprisingly, it created an international firestorm within the scientific community when it was published. (See Klinghoffer, *The Branding of a Heretic*, WALL STREET

JOURNAL, Jan. 28, 2005, as well as the following website by the editor who oversaw the article's peer-review process: <http://www.rsternberg.net>.) The treatment of the editor who sent Meyer's article out for peer-review is a striking illustration of the sociological obstacles that proponents of intelligent design encounter in publishing articles that explicitly defend the theory of intelligent design.

M.J. Behe and D.W. Snoke, "Simulating Evolution by Gene Duplication of Protein Features That Require Multiple Amino Acid Residues," *Protein Science*, 13 (2004): 2651-2664.

In this article, Behe and Snoke show how difficult it is for unguided evolutionary processes to take existing protein structures and add novel proteins whose interface compatibility is such that they could combine functionally with the original proteins. By demonstrating inherent limitations to unguided evolutionary processes, this work gives indirect scientific support to intelligent design and bolsters Behe's case for intelligent design in answer to some of his critics.

W.-E. Lönnig & H. Saedler, "Chromosome Rearrangements and Transposable Elements," *Annual Review of Genetics*, 36 (2002): 389-410.

This article examines the role of transposons in the abrupt origin of new species and the possibility of a partly predetermined generation of biodiversity and new species. The authors' approach is non-Darwinian, and they cite favorably the work of design theorists Michael Behe and William Dembski.

D.K.Y. Chiu & T.H. Lui, "Integrated Use of Multiple Interdependent Patterns for Biomolecular Sequence Analysis," *International Journal of Fuzzy Systems*, 4(3) (September 2002): 766-775.

The opening paragraph of this article reads: A Detection of complex specified information is introduced to infer unknown underlying causes for observed patterns. By complex information, it refers to information obtained from observed pattern or patterns that are highly improbable by random chance alone. We evaluate here the complex pattern corresponding to multiple observations of statistical interdependency such that they all deviate significantly from the prior or null hypothesis. Such multiple interdependent patterns when consistently observed can be a powerful indication of common underlying causes. That is, detection of significant multiple interdependent patterns in a consistent way can lead to the discovery of possible new or hidden knowledge."

M.J. Denton & J.C. Marshall, "The Laws of Form Revisited," *Nature*, 410 (22 March 2001): 417.

M.J. Denton, J.C. Marshall & M. Legge, (2002) "The Protein Folds as Platonic Forms: New Support for the pre-Darwinian Conception of Evolution by Natural Law," *Journal of Theoretical Biology* 219 (2002): 325-342.

This research is thoroughly non-Darwinian and teleological. It looks to laws of form embedded in nature to bring about biological structures. The intelligent design research program is broad, and design like this that's programmed into nature falls within its ambit.

M. Barbieri, *The Organic Codes: The Birth of Semantic Biology* (Ancona, Italy: peQuod).

This monograph summarizes Marcello Barbieri's longstanding work in formulating a semantic, and therefore intelligence-based, biology. Barbieri has published aspects of this monograph in such peer-reviewed journals as *Journal of Theoretical Biology* and *Rivista di Biologia* (see the monograph's bibliography).

Sarah A. Mims and Forrest M. Mims III, "Fungal spores are transported long distances in smoke from biomass fires," *Atmospheric Environment* 38 (2004): 651-655.

This paper illustrates the use of intelligent design as a *weak heuristic*. In this case, Mims and Mims considered the possibility that (symbiotic) mycorrhizal fungal spores might be designed to disperse in forest fires, for the purpose of re-inoculating soil that has been sterilized by fire. They even state this as a design hypothesis in their acknowledgements, and say that they intend to further test the hypothesis.

Articles Supportive of Intelligent Design Published in Peer-Reviewed Scientific Anthologies

Five science articles from *Darwinism, Design, & Public Education*, edited by John Angus Campbell and Stephen C. Meyer (Michigan State University Press, 2003) (hereinafter DDPE):

Behe, M. J., *Design in the details: The origin of biomolecular machines*. DDPE Pp. 224-286

Behe sets forth a central concept of the contemporary design argument, the notion of "irreducible complexity." Behe argues that the phenomena of his field include systems and mechanisms that display complex, interdependent, and coordinated functions. Such intricacy, Behe argues, defies the causal power of natural selection acting on random variation, the "no end in view" mechanism of neo-Darwinism. Yet he notes that irreducible complexity is a feature of systems that are known to be designed by intelligent agents. He thus concludes that intelligent design provides a better explanation for the presence of irreducible complexity in the molecular machines of the cell.

Meyer, S. C. *DNA and the origin of life: Information, specification and explanation*, DDPE Pp. 223-285.

Meyer contends that intelligent design provides a better explanation than competing chemical evolutionary models for the origin of the information present in large bio-macromolecules such as DNA, RNA, and proteins. Meyer shows that the term *information* as applied to DNA connotes not only improbability or complexity but also specificity of function. He then argues that neither chance nor necessity, nor the combination of the two, can explain the origin of information starting from purely physical-chemical antecedents. Instead, he argues that our knowledge of the causal powers of both natural entities and intelligent agency suggests intelligent design as the best explanation for the origin of the information necessary to build a cell in the first place.

Nelson, P. & J. Wells, *Homology in biology: Problem for naturalistic science and prospect for intelligent design*, DDPE, Pp. 303-322.

Paul Nelson and Jonathan Wells reexamine the phenomenon of homology, the structural identity of parts in distinct species such as the pentadactyl plan of the human hand, the wing of a bird, and the flipper of a seal, on which Darwin was willing to rest his entire argument. Nelson and Wells contend that natural selection explains some of the facts of homology but

leaves important anomalies (including many so-called molecular sequence homologies) unexplained. They argue that intelligent design explains the origin of homology better than the mechanisms cited by advocates of neo-Darwinism.

Meyer, S. C., Ross, M., Nelson, P. & P. Chien, *The Cambrian explosion: biology's big bang*, DDPE, Pp. 323-402.

Meyer, Ross, Nelson, and Chien show that the pattern of fossil appearance in the Cambrian period contradicts the predictions or empirical expectations of neo-Darwinian (and punctuationalist) evolutionary theory. They argue that the fossil record displays several features—a hierarchical top-down pattern of appearance, the morphological isolation of disparate body plans, and a discontinuous increase in information content—that are strongly reminiscent of the pattern of evidence found in the history of human technology. Thus, they conclude that intelligent design provides a better, more causally adequate, explanation of the origin of the novel animal forms present in the Cambrian explosion.

Dembski, W.A., *Reinstating design within science*, DDPE, Pp. 403-418.

Dembski argues that advances in the information sciences have provided a theoretical basis for detecting the prior action of an intelligent agent. Starting from the commonsense observation that we make design inferences all the time, Dembski shows that we do so on the basis of clear criteria. He then shows how those criteria, complexity and specification, reliably indicate intelligent causation. He gives a rational reconstruction of a method by which rational agents decide between competing types of explanation, those based on chance, physical-chemical necessity, or intelligent design. Since he asserts we can detect design by reference to objective criteria, Dembski also argues for the scientific legitimacy of inferences to intelligent design.

Articles Supportive of Intelligent Design Published in Peer-Edited Scientific Anthologies and Conference Proceedings

Scott Minnich and Stephen C. Meyer, “Genetic Analysis of Coordinate Flagellar and Type III Regulatory Circuits,” *Proceedings of the Second International Conference on Design & Nature*, Rhodes Greece, edited by M.W. Collins and C.A. Brebbia (WIT Press, 2004).

This article underwent conference peer review in order to be included in this peer-edited proceedings. Minnich and Meyer do three important things in this paper. First, they refute a popular objection to Michael Behe’s argument for the irreducible complexity of the bacterial flagellum. Second, they suggest that the Type III Secretory System present in some bacteria, rather than being an evolutionary intermediate to the bacterial flagellum, is probably represents a degenerate form of the bacterial flagellum. Finally, they argue explicitly that intelligent design is a better than the Neo-Darwinian mechanism for explaining the origin of the bacterial flagellum.

Four science articles from W. A. Dembski & M. Ruse, eds., *DEBATING DESIGN: FROM DARWIN TO DNA* (Cambridge, United Kingdom, Cambridge University Press, 2004) (hereinafter *DEBATING DESIGN*)

Dembski, W.A., *The logical underpinnings of intelligent design*, *DEBATING DESIGN*, Pp. 311-330.

In this article, Dembski outlines his method of design detection. In it he proposes a

rigorous way of identifying the effects of intelligent causation and distinguishing them from the effects of undirected natural causes and material mechanisms. Dembski shows how the presence of specified complexity or “complex specified information” provides a reliable marker or indicator of prior intelligent activity. He also responds to a common criticism made against his method of design detection, namely that design inferences constitute “an argument from ignorance.”

Bradley, W. L., *Information, Entropy, and the Origin of Life*, DEBATING DESIGN, Pp. 331-351.

Walter Bradley is a mechanical engineer and polymer scientist. In the mid-1980's he co-authored what supporters consider a seminal critique of origin of life studies in the book *The Mystery of Life's Origins*. Bradley and his co-authors also developed a case for the theory of intelligent design based upon the information content and “low-configurational entropy” of living systems. In this chapter he updates that work. He clarifies the distinction between configurational and thermal entropy, and shows why materialistic theories of chemical evolution have not explained the configurational entropy present in living systems—a feature of living systems that Bradley takes to be strong evidence of intelligent design.

Behe, M., *Irreducible complexity: obstacle to Darwinian evolution*, DEBATING DESIGN, Pp. 352-370.

In this essay Behe briefly explains the concept of irreducible complexity and reviews why he thinks it poses a severe problem for the Darwinian mechanism of natural selection. In addition, he responds to several criticisms of his argument for intelligent design from irreducible complexity and several misconceptions about how the theory of intelligent design applies to biochemistry. In particular he discusses several putative counterexamples that some scientists have advanced against his claim that irreducibly complex biochemical systems demonstrate intelligent design. Behe turns the table on these counterexamples, arguing that these examples actually underscore the barrier that irreducible complexity poses to Darwinian explanations, and, if anything, show the need for intelligent design.

Meyer, S. C., *The Cambrian information explosion: evidence for intelligent design*, DEBATING DESIGN, Pp. 371-391.

Meyer argues for design on the basis of the Cambrian explosion—the geologically sudden appearance of new animal body plans during the Cambrian period. Meyer notes that this episode in the history of life represents a dramatic and discontinuous increase in the complex specified information of the biological world. He argues that neither the Darwinian mechanism of natural selection acting on random mutations nor alternative self-organizational mechanisms are sufficient to produce such an increase in information in the time allowed by the fossil evidence. Instead, he suggests that such increases in specified complex information are invariably associated with conscious and rational activity—that is, with intelligent design.

MERE CREATION: SCIENCE, FAITH & INTELLIGENT DESIGN (William A. Dembski ed., 1998).

This book contains *fifteen* scientific and philosophical essays supportive of the theory of intelligent design written by Ph.D.-level scientists and philosophers. The book was edited by William Dembski, who holds two Ph.D.'s, one in mathematics

from the University of Chicago, and one in philosophy from the University of Illinois.

Articles Supportive of Intelligent Design Published in Peer-Reviewed Philosophy Journals

Behe, M.J., *Self-Organization and Irreducibly Complex Systems: A Reply to Shanks and Joplin*, PHILOSOPHY OF SCIENCE 67:155-162 (March 2000)

Craig, W.L., "God, Creation, and Mr. Davies." *British Journal for the Philosophy of Science* 37 (1986): 168-175

Craig, W.L., "Barrow and Tipler on the Anthropic Principle vs. Divine Design." *British Journal for the Philosophy of Science* 38 (1988): 389-395.

Craig, W.L., "The Anthropic Principle." In *The History of Science and Religion in the Western Tradition: an Encyclopedia*, pp. 366-368. Ed. G. B. Ferngren.

Craig, W.L., "Design and the Anthropic Fine-Tuning of the Universe." In GOD AND DESIGN: THE TELEOLOGICAL ARGUMENT AND MODERN SCIENCE, pp. 155-177. (ed. Neil Manson. London: Routledge, 2003).